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RADAR SPEED DETECTION: HOMING IN ON NEW EVIDENTIARY PROBLEMS

INTRODUCTION

Radar¹ has been used by law enforcement agencies to enforce vehicular speeding regulations for nearly thirty years.² During this time, the scientific reliability and accuracy of police radar devices had generally been accepted by the courts and the public.³ Recently, however, as radar technology has become more complex, the scientific reliability and accuracy of radar devices have been challenged.⁴ Consequently, the state courts have adopted conflicting views concerning the effect of radar reliability and accuracy on the admissibility and weight of radar evidence in speeding violation cases.⁵

1. Radar is an acronym for radio detection and ranging. M. Skolnik, *Introduction to Radar Systems* 1 (1962). The measurement of range, or distance, is one of radar's most important functions. *Id.* at 1-2. The simple continuous wave radar used in speed detection, however, is incapable of determining range. *Id.* at 85; see notes 7-14 *infra* and accompanying text.

2. Latin, Tannehill & White, *Remote Sensing Evidence and Environmental Law*, 64 Calif. L. Rev. 1300, 1393 (1976); McCarter, *Legal Aspects of Police Radar*, 16 Clev.-Mar. L. Rev. 455, 456 (1967). Although radar development was not significant until World War II, many experiments were performed in the 1920's and 1930's using radar techniques. See generally M. Skolnik, *supra* note 1, at 8-14. Prior to the development of radar, other devices were used to measure speed. These included the stopwatch, speedometer (not to be confused with the radar speedmeter), photographic techniques, and various electromechanical devices such as the "Speedwatch." See generally E. Fisher & R. Reeder, *Vehicle Traffic Law* 144 (1974); E. Fisher, *Legal Aspects of Speed Measurement Devices* 4-11 (1967). None of these devices, however, are as simple to operate as radar devices. The speedometer was judicially recognized as a reliable measuring device in *City of Spokane v. Knight*, 96 Wash. 403, 165 P. 105 (1917). Photographic techniques were approved in *Commonwealth v. Buxton*, 205 Mass. 49, 91 N.E. 128 (1910).

3. The courts began to take judicial notice of the general reliability and accuracy of radar speedmeters in 1955, beginning with *State v. Dantonio*, 18 N.J. 570, 115 A.2d 35 (1955). Since that decision, other states have followed. See, e.g., *People v. MacLaird*, 264 Cal. App. 2d 972, 975, 71 Cal. Rptr. 191, 193 (1968); *State v. Tomanelli*, 153 Conn. 365, 370, 216 A.2d 625, 629 (1966); *People v. Barbic*, 105 Ill. App. 2d 360, 367, 244 N.E.2d 626, 630 (1969); *People v. Abdallah*, 82 Ill. App. 2d 312, 315, 226 N.E.2d 408, 410 (1967); *Commonwealth v. Whynaught*, — Mass. —, —, 384 N.E.2d 1212, 1215 (1979); *State v. Gerdes*, 291 Minn. 353, 356-57, 191 N.W.2d 428, 429 (1971); *State v. Graham*, 322 S.W.2d 188, 195 (Mo. Ct. App. 1959); *People v. Magri*, 3 N.Y.2d 562, 566, 147 N.E.2d 728, 730, 170 N.Y.S.2d 335, 337-38 (1958); *City of E. Cleve. v. Ferrell*, 168 Ohio St. 298, 303, 154 N.E.2d 630, 633 (1958); notes 72-76 *infra* and accompanying text. The public's acceptance of radar is due in large part to the role that radar has played in the military since World War II. See Carosell & Coombs, *Radar Evidence in the Courts*, 32 Dicta 323, 324 (1955). Furthermore, "the earliest courts to rule on the matter balanced the relatively minor penalties involved against the need for effective enforcement of speeding laws and readily admitted radar evidence once the technique was proven to be reasonably reliable." Latin, Tannehill & White, *supra* note 2, at 1393 (footnote omitted); see Boyce, *Judicial Recognition of Scientific Evidence in Criminal Cases*, 8 Utah L. Rev. 313, 315-17 (1963).

4. See N.Y. Times, Nov. 27, 1979, § C, at 1, col. 6. "When Florida police clocked a . . . tree and a house moving at 28 miles an hour . . . the reports sparked a court hearing and widespread questioning of what had previously been an accepted fact of life behind the wheel—the absolute accuracy of police radar." *Id.*; see Nat'l Highway Traffic Safety Admin., U.S. Dep't of Transp., *Police Traffic Radar: Is It Reliable?* (Feb. 1980) [hereinafter cited as *Police Traffic Radar*].

5. See pt. III(D) *infra*. Compare *State v. Aquilera*, 48 Fla. Supp. 207 (Dade County Ct. 1979)

Because "minor traffic offenses constitute the only contact [the average law-abiding citizen] will have with the law enforcement and judicial systems, . . . [u]ntil a radar device is invented that is accurate under any conditions, fairness dictates that contested prosecutions are conducted according to meaningful standards which insure the instrument's accuracy."⁶ Accordingly, this Note discusses some of the basic technical and legal principles involved in use of police radar to detect speeding violations. It also suggests several legal guidelines that courts should adopt to augment traditional evidentiary standards for determining the admissibility and sufficiency of radar evidence in speeding cases.

I. FUNDAMENTAL RADAR PRINCIPLES

The development of radar technology has advanced rapidly since World War II.⁷ Most military radar units utilized in tracking, guidance, and navigation are of the "pulse" type.⁸ Police radar speedmeters, however, are of the "continuous wave" variety, which operate on the Doppler shift or effect.⁹ Although both pulse radar devices and continuous wave Doppler shift radar devices generally emit radio signals in the microwave region of the radio frequency spectrum,¹⁰ their operating principles are very different.

In the pulse type, individual pulses of radio energy are transmitted from the radar unit. These pulses reflect off objects in their path, and return to the receiving antenna of the radar unit. The distance or range of the object from the radar unit may be calculated from the time that it takes a pulse to return to the radar antenna because the speed of radio waves is a known constant—approximately the speed of light.¹¹ It should be recognized that the velocity of the distant object has not been calculated, but merely the distance of the object from the radar unit. Velocity may be calculated, however, by determining the distances that the object has moved during a time interval as determined by the reflections of successive pulses.¹²

Unlike pulse radar devices, police radar speedmeters do not use a time-distance relationship to determine the distance or velocity of a moving object.¹³ Rather, police radar devices detect the speed of a moving object by the measurement of the change in frequency caused by the reflection of radio

with *State v. Wojtkowiak*, 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979) and *State v. Hanson*, 85 Wis. 2d 233, 270 N.W.2d 212 (1978).

6. *State v. Hanson*, 85 Wis. 2d 233, 246, 270 N.W.2d 212, 219 (1978); accord, *State v. Aquilera*, 48 Fla. Supp. 207, 208 (Dade County Ct. 1979).

7. See generally M. Skolnik, *supra* note 1, at 8.

8. See *id.* at 3; Carosell & Coombs, *supra* note 3, at 326; Jacobsen, *Technology and Liability*, 51 Tul. L. Rev. 1075, 1075-92 (1977).

9. See M. Skolnik, *supra* note 1, at 3; Kopper, *The Scientific Reliability of Radar Speedmeters*, 33 N.C.L. Rev. 343, 344-46 (1955). The Doppler effect was first pronounced by Christian Johann Doppler in 1842. *Id.* at 346.

10. See M. Skolnik, *Radar Handbook* § 1.4, at 1-11 (1970) [hereinafter cited as *Radar Handbook*]; *Microwave Systems News*, Aug. 1977, at 81.

11. See M. Skolnik, *supra* note 1, at 2; Kopper, *supra* note 9, at 345.

12. See *Radar Handbook*, *supra* note 10, § 1.3, at 1-9.

13. See Carosell & Coombs, *supra* note 3, at 325. Simple continuous wave radar is not capable of determining range. M. Skolnik, *supra* note 1, at 85.

waves off that object. This change in frequency is known as the Doppler shift.¹⁴ The Doppler shift can be described as the emission from a moving source, of a light, sound or radio wave, the frequency of which will be changed proportionately to the speed of the source. If the source is approaching the observer, the frequency will be increased. If the source is receding, the frequency will be decreased.¹⁵ By measuring this frequency change, the speed of the source may be determined.¹⁶

In the typical police radar situation, a patrol car containing a radar unit is stationed along the side of a highway, with the radar beam directed down the road toward approaching traffic.¹⁷ The region along the roadway in which the radar device can respond to a moving vehicle is known as the "zone of influence."¹⁸ When an automobile enters the zone of influence, it will reflect a sufficient amount of microwave energy to be received by the radar unit. The difference in frequency between the reflected and transmitted signals is determined electronically by the radar unit and converted into a speed reading.¹⁹ The older speedmeters used a meter type of display, often in conjunction with a graphic recording device.²⁰ The modern units utilize a digital type display similar to that used in modern electronic calculators.²¹

14. See 1 R. Resnick & D. Halliday, *Physics* § 20-7, at 512 (1966); Kopper, *supra* note 9, at 345-46.

15. See Kopper, *supra* note 9, at 346. The Doppler shift is a well known principle of physics. The sudden change in pitch of a car horn as it is passed by is a familiar example. *Id.* "Assume a passenger at a station awaiting a train. Down track the train approaches at 50 mph. The engineer blows his whistle, which sounds a single high-pitched note. The awaiting passenger will hear that single note slide up the scale or . . . its frequency increases. This natural phenomenon, imparting the vaguely romantic wailing sound of approaching or receding train whistles, is the Doppler effect (or 'shift') at an audible frequency." *State v. Wojtkowiak*, 170 N.J. Super. 44, 48-49, 405 A.2d 477, 480 (Super. Ct. Law Div. 1979).

16. Kopper, *supra* note 9, at 346-49. The same Doppler shift occurs when radio waves strike a moving target and are reflected: the moving target, such as an automobile, acts as a source and the reflected wave will be changed in frequency depending on the speed and direction of the moving target. *Id.* at 347.

17. See, e.g., Police Dep't of the City of New York, *Highway District Radar Manual*, at 2 [hereinafter cited as *Highway District Radar Manual*].

18. See 11 Am. Jur. *Proof of Facts*, Proof No. 2, at 21 (Supp. 1979) (description of zone of influence); *Highway District Radar Manual*, *supra* note 17, at 11 (zone of influence defined for a Decatur model 989 radar speedmeter). The zone of influence is affected by many factors, such as the size of the vehicle, the composition of the vehicle, output power of the radar device, and the physical conditions surrounding the road. A typical range for a passenger car is 1500 feet. Because of their greater cross-sectional area, larger vehicles such as trucks, will cause a response by the radar at much greater distances. See Law Enforcement Standards Laboratory Center for Consumer Product Technology, Nat'l Bureau of Standards, *Field Operational Characteristics of Speed Measuring Devices*, Dec. 1978, at 5 [hereinafter cited as *Field Operational Characteristics*]. See also *Interim Report*, in *Police Traffic Radar*, *supra* note 4, at 12-14 (radar range test data for various types of vehicles).

19. See Kopper, *supra* note 9, at 349-50; *Microwave Systems News*, *supra* note 10, at 81-82.

20. See 11 Am. Jur. *Proof of Facts*, Proof No. 3, at 57 (Supp. 1979) (example of a typical graph recording from a radar speedmeter).

21. See *Microwave Systems News*, *supra* note 10, at 82 (illustration of a typical digital type device).

Additional refinements in the modern radar units include automatic lock-on²² and the ability to measure the speed of an approaching vehicle while the police car containing the radar unit is in motion.²³ The scientific reliability and accuracy of these innovations have been the source of judicial controversy regarding the admissibility and sufficiency of radar evidence in speeding cases.²⁴

II. RELIABILITY PROBLEMS

Although radar has gained widespread judicial and public acceptance,²⁵ and the fundamental scientific principles of Doppler shift radar are generally indisputable,²⁶ many practical and technical considerations affect the reliability of police radar speed detection devices. Like all scientific instruments, radar devices have sources of error.²⁷ The consequent evidentiary problems have traditionally been avoided when the prosecution has been able to establish that the radar devices were properly tested and operated.²⁸ In several recent cases, however, the courts have differed on the importance and effect of radar speedometer errors on reliability.²⁹ As a result, the admissibility and weight of new forms of radar evidence are uncertain. Thus, to establish guidelines that can aid in determining the admissibility and weight of radar evidence, it is necessary to consider the more significant technical problems that affect the reliability of radar speed detection devices.

22. See notes 60-66 *infra* and accompanying text.

23. Microwave Systems News, *supra* note 10, at 82. Moving radar devices are a relatively new innovation. These devices allow an operator in a moving radar-equipped patrol car to measure the speed of an approaching vehicle. *Id.* Radar devices that cannot be used while the patrol car is in motion are known as stationary radar speedometers. Moving radar devices can be used in either "moving mode" or "stationary mode" by switching the mode of operation. See *State v. Wojtkowiak*, 170 N.J. Super. 44, 50-51 & n.2, 405 A.2d 477, 481 & n.2 (Super. Ct. Law Div. 1979).

24. See notes 32-38, 60-66 *infra* and accompanying text.

25. See cases cited note 3 *supra*; notes 74-76 *infra* and accompanying text.

26. See generally Kopper, *supra* note 9; Strong, *Questions Affecting the Admissibility of Scientific Evidence*, 1970 U. Ill. L.F. 1, 11. "In light of society's widespread use of radar devices, in forms ranging from air-traffic control monitors to homing radars on guided missiles, and considering other courts' acceptance of radar, we view the scientific basis of radar as indisputable." *Commonwealth v. Whynaught*, — Mass. —, —, 384 N.E.2d 1212, 1215 (1979) (footnote omitted).

27. See generally Carosell & Coombs, *supra* note 3, at 329-42 (description of some technical limitations of early radar devices); see also *Interim Report* in *Police Traffic Radar*, *supra* note 4, at 3-10; *Field Operational Characteristics*, *supra* note 18, at 11-16.

28. See, e.g., *State v. Harper*, 382 A.2d 263 (Del. Super. Ct. 1978); *People v. Stankovich*, 119 Ill. App. 2d 187, 255 N.E.2d 461 (1970); *State v. Dantonio*, 18 N.J. 570, 115 A.2d 35 (1955). "[T]he possibility of error would not wholly deny the admissibility of the radar evidence but would simply affect its weight" *Id.* at 580, 115 A.2d at 40.

29. E.g., *State v. Aquilera*, 48 Fla. Supp. 207 (Dade County Ct. 1979); *State v. Fedje*, No. T-1979-725387 MO (Dist. Ct. Hawaii Nov. 14, 1979); *State v. Wojtkowiak*, 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979); *State v. Hanson*, 85 Wis. 2d 233, 270 N.W.2d 212 (1978).

A. *Cosine and Related Errors*

A characteristic of continuous wave Doppler shift radar speedmeters is that the devices respond to the radial component of a moving object's velocity—the component of the velocity that is in the direction of the line of sight of the radar beam.³⁰ Therefore, if an angle between the direction of motion of the vehicle and the radar beam exists, the speedmeter will not measure the actual velocity, but only the component of the velocity in the direction of the beam. This error, referred to as a “cosine error,” is generally minimal for small angles and results in the measurement of a speed that is less than the true vehicular speed. Thus, the error favors the motorist.³¹

The problem becomes more significant, however, in the case of “moving radar.”³² Basically, a moving radar device allows measurement of the speed of an approaching vehicle while the police car containing the radar unit is itself in motion.³³ The speedmeter processes two return signals. The first is the reflected signal from the target vehicle. Because both vehicles are in motion, however, the Doppler frequency is proportionate to the combined relative speed of the police car and target vehicle. It is apparent that the speed of the police car must be subtracted to obtain the correct speed. Thus, the radar device is designed to accept a second input signal, which is the reflection of the transmitted signal from the ground and surrounding stationary objects.³⁴ The speed of the police car may be obtained from this Doppler

30. See Carosell & Coombs, *supra* note 3, at 334, 346-47; Kopper, *supra* note 9, at 351.

31. See Kopper, *supra* note 9, at 351. Dr. Kopper explains that the speed of a moving car, given in terms of the Doppler or difference frequency and the transmitted frequency is: $V = F_D c / 2F_T$, in which F_D = the Doppler or difference frequency between the transmitted and received signals; F_T = the transmitted frequency; and c = the speed of light. *Id.* at 350. Furthermore, he explains, the more accurate formula is: $V = F_D c / 2F_T \cos A$, in which A is the angle between the direction of motion of the car and the line of sight along the radar beam. Only when the direction of motion of the car and the line of sight are the same does the speedmeter measure the true velocity. In all other cases, the true velocity, as indicated by the second formula, is greater than the velocity measured by the speedmeter. *Id.* at 351. In fact, if the vehicle was travelling perpendicular to the direction of the radar beam, the measured velocity would be zero. See M. Skolnik, *supra* note 1, at 86. If the velocity in the first formula is equal to the velocity measured by the speedmeter, it becomes apparent that the true velocity would equal the measured velocity divided by the cosine term; or $V_{\text{measured}} = V_{\text{true}} \cos A$. Thus, the name “cosine error.” It should also be noted that radar operation manuals require that the angle between the radar beam and the path of travel of the vehicle should be as small as practical to minimize the cosine error. *E.g.*, Highway District Radar Manual, *supra* note 17, at 20; *Interim Report*, in Police Traffic Radar, *supra* note 4, at 8.

32. See Microwave Systems News, *supra* note 10, at 82.

33. *Id.*

34. *Id.* “As the patrol car moves over the road, the microwaves reflected from the road will arrive back at the receiver at a frequency, predicted by the Doppler formula, varying with the speed of the patrol car. . . . [A]ssume a target vehicle approaches the patrol car. Microwaves reflected from the target vehicle will arrive back at the receiver at a frequency predicted by the Doppler formula varying with the sum of the speeds of both cars. . . . Because of a single variable, speed, in one case relative to the road and, in another case, relative to a closing vehicle, two completely distinct frequencies have been generated, which can be computed into the speeds that generated them.” *State v. Wojtkowiak*, 170 N.J. Super. 44, 51-52, 405 A.2d 477, 481 (Super. Ct. Law Div. 1979).

frequency, which is proportionate to the police vehicle speed, because the reflection is from a stationary target. The speed of the target vehicle is determined electronically by subtracting the police car speed from the combined speed.³⁵

If the police vehicle speed is incorrectly calculated to be less than its actual velocity, the above subtraction will yield a velocity of the target vehicle that is greater than the true velocity. Thus, a potentially serious error could result.³⁶ An incorrect measurement could occur, for example, if an angle is introduced between the direction of motion of the patrol car and a stationary object along the side of the road, such as a billboard, which has a strong microwave reflecting quality.³⁷ This angle results in a cosine error, which if sufficiently great, will reduce the calculated police car speed, and thus increase the calculated speed of the target vehicle.³⁸

Other phenomena that result in the calculation of incorrect patrol car speeds include "add-on," "shadowing," and "batching."³⁹ Add-on occurs when the radar speedmeter accidentally adds to the speed of the target vehicle the difference in speed between the patrol car and a vehicle being passed (or one that is passing the patrol car), while both are going in the same direction.⁴⁰ Similarly, when the patrol car passes or is overtaken by another vehicle a shadowing effect may result. The return signal from the ground is temporarily supplanted by the reflection from the passed or passing vehicle. Because the speed of the patrol car relative to this car is less than the true patrol car speed, the speed of the patrol car will be incorrectly measured, resulting in a calculation of greater than actual target vehicle speed.⁴¹ Finally,

35. Microwave Systems News, *supra* note 10, at 82; see *State v. Wojtkowiak*, 170 N.J. Super. 44, 51-53, 405 A.2d 477, 480-82 (Super. Ct. Law Div. 1979) (description of principles of moving radar as applied to MPH K55 radar device); *State v. Hanson*, 85 Wis. 2d 233, 239, 270 N.W.2d 212, 215-16 (1978) (Kustom Signals MR-7 moving radar device).

36. *State v. Wojtkowiak*, 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979) "This is, potentially, a serious matter since reduced patrol car speed would result in false, higher target speed readings." *Id.* at 58, 405 A.2d at 484-85.

37. See *id.* at 58, 405 A.2d at 484-85; *State v. Hanson*, 85 Wis. 2d 233, 243, 270 N.W.2d 212, 217 (1978). See also N.Y. Times, Nov. 27, 1979, § C, at 3, col. 1.

38. Expert defense witnesses in several cases testified to the theory of cosine error. *E.g.*, *State v. Aquilera*, 48 Fla. Supp. 207, 209 (Dade County Ct. 1979); *State v. Wojtkowiak*, 170 N.J. Super. 44, 58, 405 A.2d 477, 484 (Super. Ct. Law Div. 1979); *State v. Hanson*, 85 Wis. 2d 233, 243, 270 N.W.2d 212, 217 (1978). In recent tests by the Law Enforcement Standards Laboratory, however, the cosine error was found to have no practical effect on radar devices. *Interim Report*, in *Police Traffic Radar*, *supra* note 4, at 8. Thus, the error seems to be a theoretical, and not a practical problem.

39. See *Interim Report*, in *Police Traffic Radar*, *supra* note 4, at 3-10 (description of these and other radar speed measuring device errors).

40. See *Field Operational Characteristics*, *supra* note 18, at 16.

41. See *State v. Wojtkowiak*, 170 N.J. Super. 44, 61, 405 A.2d 477, 486 (Super. Ct. Law Div. 1979); *Interim Report*, in *Police Traffic Radar*, *supra* note 4, at 3-5, 25-26. In recent tests of radar devices by the Law Enforcement Standards Laboratory, shadowing was a serious error in the operation of radar devices. One particular radar device recorded target vehicle speeds of 68 to 80 mph when the actual target speeds ranged from 50 to 60 mph and actual patrol speeds were 30 to 40 mph. *Id.* at 5.

batching is the consequence of patrol car speed changes while the moving radar device is in operation. The speedometer may incorrectly display a changing target vehicle speed, even though the speed of the target vehicle has actually remained constant.⁴²

Although these technical deficiencies are often raised by defendants challenging speeding violations, in certain contexts, reliability problems can be minimized. For example, in *State v. Wojtkowiak*,⁴³ the court noted that the radar device in question had a dual display that indicated both the speed of the target vehicle and the speed of the patrol car. As a result, the police officer could constantly check the accuracy of the device by comparing the speed measured by the radar device with that of the patrol car speedometer.⁴⁴ Conversely, in *State v. Hanson*,⁴⁵ the court found that the police officer did not adequately check to determine whether the speedometer accurately measured the patrol car speed. The court concluded that such a check is an important safeguard in ascertaining an accurate radar reading, and included this in guidelines it established to determine the sufficiency of radar evidence.⁴⁶

B. Interference

Like any electronic device, the police radar speedometer is subject to external interference, or "noise," from electrical and mechanical sources.⁴⁷ For example, electromagnetic interference caused by automobile ignition, heater fans, high voltage wires, signs, and police and citizens' band radio transmissions have been known to cause erroneous displays.⁴⁸ Other mechanical sources can also interfere with speed detection because anything that moves in the radar zone of influence can produce a Doppler shift and create an erroneous reading.⁴⁹ Generally, however, these sources of error are

42. See *Interim Report*, in *Police Traffic Radar*, *supra* note 4, at 5-6, 17.

43. 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979).

44. *Id.* at 62, 405 A.2d at 486.

45. 85 Wis. 2d 233, 270 N.W.2d 212 (1978).

46. *Id.* at 245, 270 N.W.2d at 218.

47. See *Interim Report*, in *Police Traffic Radar*, *supra* note 4, at 10, 15-18; *Field Operational Characteristics*, *supra* note 18, at 14-16; Carosell & Coombs, *supra* note 3, at 336-39; Kopper, *supra* note 9, at 351-52.

48. *Field Operational Characteristics*, *supra* note 18, at 5, 11-16. The two most common types of police radar in use today operate on "X" and "K" bands in the microwave region of the frequency spectrum. X band radar operates at 10.525 GHz (10.525 billion cycles per second) and K band radar operates at 24.150 GHz. Old "S" band (2.455 GHz) radar speedometers are virtually obsolete. See *Microwave Systems News*, *supra* note 10, at 81. See also *Radar Handbook*, *supra* note 10, § 1.4 Table 1, at 1-11. Any device that produces electromagnetic energy at these frequencies can interfere with radar units. Generally, this interference is caused by "harmonics" (multiples of lower frequencies) that are inadvertently produced by other electrical devices. A police department, for example, indicated that its mobile radio transmissions at 154.77 and 156.21 MHz (million cycles per second) interfered with its radar units. *Field Operational Characteristics*, *supra* note 18, at 5. Radar jamming near airports is also a problem. *Id.* at 11.

49. See, e.g., Kopper, *supra* note 9, at 352. Incorrect readings have also been noticed during rainy periods. *Field Operational Characteristics*, *supra* note 18, at 16. "Ghosting," or the

minor,⁵⁰ and an experienced operator should be able to identify them.⁵¹

C. Identification Problems

A common defense raised in the early radar cases was that the defendant's vehicle was not the one speeding.⁵² In dense traffic situations, separation of one car from another is difficult⁵³ because the radar speedmeter cannot distinguish one target from another.⁵⁴ Usually, the closest target will be

reflection off moving objects out of the operator's visual range, can also cause spurious readings. E.g., *State v. Wojtkowiak*, 170 N.J. Super. 44, 61, 405 A.2d 477, 486 (Super. Ct. Law Div. 1979).

50. See *Kopper*, *supra* note 9, at 352. Not all interfering sources cause insignificant readings. For example, mercury vapor lamps caused readings of 80 to 84 mph; radio transmissions caused speed readings of 111 mph; and heater fans caused speed readings varying from 22 to 55 mph. *Field Operational Characteristics*, *supra* note 18, at 16.

51. *Field Operational Characteristics*, *supra* note 18, at 16. If the "false" readings are transient in nature, the operators should know that these readings should be disregarded. When the "auto-lock" feature is utilized, however, the radar speedmeter locks on the first signal it receives that is over the speed limit. See notes 60-66 *infra* and accompanying text. Thus, operators may be confused because the radar speedmeter might be responding to a source other than an approaching automobile. During tests of moving radar devices, for example, a police department experienced the problem of the radar unit locking onto the patrol car fan motor as the indicator of the patrol car speed, thus causing false readings. *Field Operational Characteristics*, *supra* note 18, at 16.

52. See, e.g., *People v. Cash*, 103 Ill. App. 2d 20, 242 N.E.2d 765 (1968); *Commonwealth v. Bartley*, 411 Pa. 286, 191 A.2d 673 (1963). The defendant in *Bartley* contended that the radar speedmeter had registered the speed of a vehicle traveling in the opposite direction, and that other vehicles were passing his vehicle at the time of the alleged violation, thereby raising doubt as to which vehicle's speed was measured by the radar device. *Id.* at 293, 191 A.2d at 676. The court upheld the conviction although the incident occurred at night and many other vehicles were present. Justice Musmanno, dissenting, noted that proper identification was unlikely. "But the doubt which is generated when only two cars are involved becomes a complete rout, so far as technical accuracy is concerned, when three, four or five vehicles are within the radar beam simultaneously." *Id.* at 299, 191 A.2d at 680 (Musmanno, J., dissenting).

53. See *McCarter*, *supra* note 2, at 463. The author cites a test in which 80 to 90% of the vehicles could be separately identified at a flow rate of 500 vehicles per hour "But positive identification of all individual speeds becomes impossible at flows in excess of 1,000 vehicles per hour on multi-lane roads." *Id.* (footnote omitted); see Note, *Proposal for a Uniform Radar Speed Detection Act*, 7 U. Mich. J.L. Ref. 440, 445 n.53 (1974) [hereinafter cited as *Uniform Act*]. The author describes a demonstration of a radar device by an experienced operator on a multi-lane road. The operator admitted that he was not able to identify individual vehicles on three or four lane roads. *Id.* The new smaller hand held radars help in this respect because they can be aimed at traffic to aid in vehicle separation. *Microwave Systems News*, *supra* note 10, at 82; see *Interim Report in Police Traffic Radar*, *supra* note 4, at 20 ("When two or more vehicles are in the radar beam, it can be difficult to select the correct target."); *Field Operational Characteristics*, *supra* note 18, at 13 ("Absolute identification is difficult if there are confusing targets, e.g., several lanes of traffic, with both large and small vehicles.").

54. If there are multiple targets in the radar beam, the speedmeter will record the speed of the vehicle that reflects the strongest signal. See *State v. Wojtkowiak*, 170 N.J. Super. 44, 53-54, 405 A.2d 477, 482 (Super. Ct. Law Div. 1979); 11 Am. Jur. *Proof of Facts*, Proof No. 2, at 21 (Supp. 1979).

detected.⁵⁵ Larger objects such as trucks, however, may be detected even though a car is closer to the radar unit, due to the objects' greater reflective area.⁵⁶ Other factors that influence which vehicle is detected include the shape, composition,⁵⁷ and speed of the vehicle.⁵⁸ Identification is even more difficult when modern moving radar is used. According to one police department, "it [is] easy to misinterpret the reading and misidentify the vehicle being tracked when using moving radar. In addition, the greater ranges obtained using the new radars [create] the possibility of more errors."⁵⁹

D. Automatic Lock Systems

The automatic lock or automatic feature⁶⁰ of modern radar speedmeters allows the operator to preset a certain speed—generally the violation speed. If the radar detects a signal corresponding to a speed exceeding the speed limit, an alarm sounds, alerting the operator that a violation has occurred. In addition, the speedmeter automatically "locks on" to the speed reading.⁶¹ The problem with this feature is that the operator may not have been attentively following traffic. Thus, he cannot identify the vehicle that caused the reading that exceeded the speed limit,⁶² or determine whether the reading was even

55. The courts generally adhere to the rule that the target closest to the radar unit, when out in front of other traffic, is the violator. *E.g.*, *State v. Harper*, 382 A.2d 263, 264 (Del. Super. 1978); *State v. Wojtkowiak*, 170 N.J. Super. 44, 56-57, 405 A.2d 477, 484 (Super. Ct. Law Div. 1979).

56. *E.g.*, *State v. Wojtkowiak*, 170 N.J. Super. 44, 57, 405 A.2d 477, 484 (Super. Ct. Law Div. 1979). An independent test by a leading national automotive magazine found that a large tractor trailer truck would be detected at over 7500 feet from the radar device, while passenger automobiles typically came into range at considerably less than 2000 feet. *Bedard, Radar Range, Car and Driver*, Oct. 1979, at 78-82; *see N.Y. Times*, Nov. 27, 1979, § C, at 1, col. 2, at 3, cols. 2-3 (citing test by *Car and Driver*).

57. *See Bedard, supra* note 56, at 78-82. For example, the Chevrolet Corvette, with its sports car shape and fiberglass body, was not easily detected until it came within about 520 feet of the radar device. *Id.* at 79.

58. *See Kopper, supra* note 9, at 352. Radar speedmeters are designed to select the higher of two returning frequencies, all other factors being equal. Thus, the speedmeter will generally record the speed of the fastest moving vehicle. *Id.*; *see 11 Am. Jur. Proof of Facts*, Proof No. 2, at 21 (Supp. 1979).

59. *Field Operational Characteristics, supra* note 18, at 15.

60. *See Interim Report*, in *Police Traffic Radar, supra* note 4, at 8. *See also State v. Wojtkowiak*, 170 N.J. Super. 44, 63, 405 A.2d 477, 487 (Super. Ct. Law Div. 1979) (automatic feature described for MPH K-55 radar device); *Highway District Radar Manual, supra* note 17, at 25 (automatic feature described for Decatur Rangemaster 715 radar).

61. *See Highway District Radar Manual, supra* note 17, at 25; *Microwave Systems News, supra* note 10, at 82.

62. Operators of radar devices preferred the automatic feature of radar "which alerts the officer when a violation has been detected, thereby freeing his attention for other duties in the meantime." *Field Operational Characteristics, supra* note 18, at 6; *see N.Y. Times*, Nov. 27, 1979, § C, at 1, col. 2, at 3, col. 3. Therefore, the officer does not know which vehicle the radar device was pointed at, and must decide after the violation has occurred which vehicle activated the alarm. The possibility for error is great under these circumstances. *See Interim Report*, in *Police Traffic Radar, supra* note 4, at 8 (describing disadvantages of the automatic lock feature).

caused by a speeding vehicle.⁶³ In *State v. Wojtkowiak*,⁶⁴ the court found that the validity of a radar device used in the automatic position is more questionable than when the device is used in the "manual" mode.⁶⁵ In fact, the court noted that use of the speedometer in the automatic mode was not recommended by the manufacturer and had been forbidden by the state police.⁶⁶

In sum, the more significant reliability problems that have been encountered either in theory or practice, necessitate a comprehensive and sophisticated treatment of radar evidence. The traditional rules for the admission and sufficiency of radar evidence do not adequately scrutinize technical deficiencies and fail to accommodate them within the legal context. Accordingly, a set of guidelines must be developed that acknowledges that technical errors exist, yet accounts for them in the admission and weighing process.

III. THE FOUNDATION FOR RADAR EVIDENCE

A prosecution for a speeding violation is a criminal proceeding in nature,⁶⁷ and thus, the government must produce sufficient evidence to demonstrate that the defendant is guilty beyond a reasonable doubt.⁶⁸ The courts that

63. It is entirely possible that the radar unit could lock onto a spurious interfering noise signal that is totally unrelated to the speed of the traffic. Because the operator cannot conscientiously monitor the speedometer if he is performing other duties simultaneously, he might mistake the spurious reading for an actual violation. "[T]he radar may automatically lock-on to a stray abnormal reading which only appeared momentarily due to an unobserved interference source." *Interim Report*, in *Police Traffic Radar*, *supra* note 4, at 8.

64. 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979).

65. *Id.* at 63, 405 A.2d at 487. The "manual" mode allows the operator to "lock-in" a speed manually once the target is identified and the reading has stabilized. In the automatic position, however, the radar unit itself automatically locks on the first signal that exceeds the speed limit. *Id.* at 53, 405 A.2d at 482. Certain radar units, when used in the automatic mode, will update the speed reading of the target vehicle, but only if the vehicle is accelerating. If the vehicle is decelerating, the device will lock on the highest speed attained. Highway District Radar Manual, *supra* note 17, at 25.

66. 170 N.J. Super. at 53, 63, 405 A.2d at 482, 487.

67. See, e.g., *People v. Perlman*, 15 Ill. App. 2d 239, 145 N.E.2d 762 (1957); *State v. Ring*, 85 N.J. Super. 341, 204 A.2d 716 (Super. Ct. Law Div. 1964), *cert. denied*, 382 U.S. 812 (1965); *People v. Hildebrandt*, 308 N.Y. 397, 126 N.E.2d 377, 140 N.Y.S. ____ (1955); *People v. Barone*, 24 Misc. 2d 1020, 205 N.Y.S.2d 914 (Orleans County Ct. 1960); *People v. Fiore*, 9 Misc. 2d 468, 170 N.Y.S.2d 726 (Ct. Spec. Sess. 1957); *People v. Sperbeck*, 5 Misc. 2d 849, 165 N.Y.S.2d 958 (Otsego County Ct. 1957); *Commonwealth v. Brose*, 412 Pa. 276, 194 A.2d 322 (1963). Because traffic violations are minor offenses, usually punishable by a fine, they are sometimes classified as "quasi-criminal" and, therefore, the courts have not always applied every constitutional safeguard of criminal cases. See, e.g., *State v. Tropea*, 78 N.J. 309, 316, 394 A.2d 355, 358 (1978) (court refused to decide whether double jeopardy applied, but stated "constitutional compulsion aside, it is plain to us that considerations of fundamental fairness militate against any retrial in this case."); see *Boyce*, *supra* note 3, at 315-17.

68. See, e.g., *People v. Stankovich*, 119 Ill. App. 2d 187, 188, 255 N.E.2d 461, 461 (1970); *Kansas City v. Oxley*, 579 S.W.2d 113, 114 (Mo. 1979); *State v. Readding*, 160 N.J. Super. 238, 243, 389 A.2d 512, 515 (Super. Ct. Law Div. 1978); *People v. Cunha*, 93 Misc. 2d 467, 471, 402 N.Y.S.2d 925, 927 (Nassau County Dist. Ct.), *aff'd*, 96 Misc. 2d 522, 409 N.Y.S.2d 387 (Sup. Ct. App. Term 1978); *People v. Perlman*, 89 Misc. 2d 973, 981, 392 N.Y.S.2d 985, 991 (Suffolk

have considered radar evidence have traditionally determined that the burden of the prosecution consists of three requirements: first, proof of the general scientific reliability of the radar device; second, proof of the accuracy of the particular device in question; third, proper operation of the device at the time of the alleged violation by a qualified operator.⁶⁹

A. General Scientific Reliability

The courts in early radar cases required expert testimony on the subject of the general scientific reliability of radar devices.⁷⁰ Therefore, a radar engineer or some other qualified expert was required to testify to the basic operating principles and reliability of police radar units. This judicial position continued until 1955, when in *State v. Dantonio*,⁷¹ the New Jersey Supreme Court took judicial notice⁷² of the "general nature and trustworthiness"⁷³ of police radar. Thus, until recently, the scientific reliability of radar speedmeters was generally established and was not required to be proven by the prosecution.⁷⁴

County Dist. Ct. 1977); *State v. Bonar*, 40 Ohio App. 2d 360, 363, 319 N.E.2d 388, 390 (Ct. App. 1973).

69. See, e.g., *State v. Gerdes*, 291 Minn. 353, 359, 191 N.W.2d 428, 432 (1971); *State v. Readding*, 160 N.J. Super. 238, 243, 389 A.2d 512, 515 (Super. Ct. Law Div. 1978). See generally C. McCormick, *Handbook of the Law of Evidence* § 210, at 514-15 (2d ed. 1972); A. Moenssens, R. Moses & F. Inbau, *Scientific Evidence in Criminal Cases* § 13.08, at 534 (1973); J. Wigmore, *The Science of Judicial Proof* 450 (3d ed. 1937); Goger, *Proof, By Radar Or Other Mechanical or Electronic Devices, of Violation of Speed Regulations*, 47 A.L.R.3d 822, 827 (1973); 14 Sw. L.J. 394, 396 (1960).

70. E.g., *State v. Moffitt*, 48 Del. 210, 100 A.2d 778 (1953); *Buffalo v. Beck*, 205 Misc. 757, 130 N.Y.S.2d 354 (Sup. Ct. 1954); *People v. Offermann*, 204 Misc. 769, 125 N.Y.S.2d 179 (Sup. Ct. 1953). Expert testimony can perform several functions in connection with the introduction of radar evidence: "(1) to establish the reliability of the scientific theories and techniques embodied in a class of sensors; (2) to document that the particular device employed to obtain the submission was constructed and operated in a manner consistent with those scientific principles; (3) to identify the submission as the sensing output originally produced or its lineal descendent; and (4) to interpret the information in a way that makes it meaningful to the trier of fact." Latin, Tannehill & White, *supra* note 2, at 1366.

71. 18 N.J. 570, 115 A.2d 35 (1955).

72. C. McCormick, *supra* note 69, § 328, at 758. McCormick describes two categories of facts that fall within the concept of judicial notice: "facts generally known with certainty by all the reasonably intelligent people in the community and facts capable of accurate and ready determination by resort to sources of indisputable accuracy." *Id.* The scientific principles of police radar belong within the latter category. *Id.* § 330, at 763. Essentially, if a fact is judicially noticed the party having the burden of establishing the scientific reliability of radar principles is relieved of the duty to establish formal proof by expert testimony. *Id.* § 328, at 757.

73. 18 N.J. at 578, 115 A.2d at 40. "[I]t would seem that evidence of radar speedmeter readings should be received in evidence upon a showing that the speedmeter was properly set up and tested . . . without any need for independent expert testimony by electrical engineers as to its general nature and trustworthiness." *Id.*

74. See cases cited note 3 *supra*; 2 G. Lacy & M. Barzelay, *Scientific Automobile Accident Reconstruction* § 1.06[1][h], at 12-167 (1979). The courts in recent cases, however, have increasingly required expert testimony on the issue of radar reliability, especially when innovations, such as moving radar or speed guns, have been introduced as evidence of a speeding violation. Thus, in *State v. Hanson*, 85 Wis. 2d 233, 239-43, 270 N.W.2d 212, 216-18 (1978), expert testimony was required to establish the reliability of a moving radar device. Similarly, the

Furthermore, by statute, some states have expressly or implicitly⁷⁵ taken notice of the general reliability of radar devices by permitting their use for speed detection.⁷⁶ The effect of these provisions is that judicial notice by the courts in those states is not necessary, and the prosecution is not required to produce expert testimony to prove the general reliability and operating principles of radar.⁷⁷

New York courts have refused to extend the principle of judicial notice to moving radar devices. *E.g.*, *People v. Winter*, N.Y.L.J., Jan. 30, 1979, at 12, col. 4 (App. Term 2d Dep't 1979); *People v. Mangelberg*, N.Y.L.J., Nov. 21, 1977, at 14, col. 5 (App. Term 2d Dep't 1977); *People v. Lampert*, N.Y.L.J., May 31, 1977, at 14, col. 2 (App. Term 2d Dep't 1977). *accord*, *State v. Wilcox*, 40 Ohio App. 2d 380, 319 N.E.2d 615 (1974). *But see* *State v. Wojtkowiak*, 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979); *State v. Musgrave*, 169 N.J. Super. 204, 404 A.2d 650 (Super. Ct. Law Div. 1979); *State v. Shelt*, 46 Ohio App. 2d 115, 346 N.E.2d 345 (1976). In these cases the scientific reliability of particular moving radar devices was established by expert testimony. Thus, in future cases in these states, the courts should judicially notice the general reliability of these particular moving radar devices now that it has been established by expert testimony. Another device that has gained prominence in speed detection and that has been judicially recognized is the Visual Average Speed Computer and Recorder (VASCAR). The device is essentially a computer that calculates average speed from time and distance measurements. *See* 2 G. Barzelay & M. Lacy, *supra*, § 1.06 [1][h], at 12-174 to 176. The operator enters a distance measurement of a predetermined section of roadway by turning a switch on and off while the patrol car is driven over this section of highway. By turning another switch on and off the device measures the time taken by a suspect vehicle to travel this distance. The unit automatically calculates the average speed of the vehicle once these two quantities have been entered. *E.g.*, *State v. Schmiede*, 118 N.J. Super. 576, 578-79, 289 A.2d 281, 282-83 (Somerset County Ct. 1972). One of the first cases involving VASCAR was *People v. Persons*, 60 Misc. 2d 803, 303 N.Y.S.2d 728 (Ct. Spec. Sess. 1969). The court did not take judicial notice of the operating principles and reliability of the device but required expert testimony to admit the evidence. *Id.* at 803, 303 N.Y.S.2d at 729-30; *accord*, *People v. Leatherbarrow*, 69 Misc. 2d 563, 330 N.Y.S.2d 676 (Erie County Ct. 1972). The New Jersey courts, however, have since taken judicial notice of VASCAR. *State v. Salup*, 128 N.J. Super. 209, 211, 319 A.2d 739, 740 (Super. Ct. App. Div. 1974); *State v. Finkle*, 128 N.J. Super. 199, 207, 319 A.2d 733, 737 (Super. Ct. App. Div. 1974). Thus, as in the case of radar, a period of judicial reluctance to accept scientific evidence without expert testimony has been followed by judicial notice of the underlying principles and general reliability of the device. C. McCormick, *supra* note 69, § 210, at 516. Although the court reversed a speeding conviction in *City of St. Louis v. Martin*, 548 S.W.2d 622 (Mo. Ct. App. 1977), on the grounds that the VASCAR unit had not been sufficiently checked for accuracy, it seemed to have implicitly accepted the concept of judicial notice of the underlying principles and general reliability of VASCAR.

75. *See* C. McCormick, *supra* note 69, § 210, at 515; A. Moenssens, R. Moses & F. Inbau, *supra* note 69, at 534.

76. *See* Fla. Stat. Ann. § 316.1905 (West Supp. 1978); Ga. Code Ann. §§ 68-2101 to -2113 (1975 & Supp. 1979); Me. Rev. Stat. Ann. tit. 29, § 1254 (1965 & West Supp. 1977); Md. Cts. & Jud. Proc. Code Ann. § 10-301 (1980); Minn. Stat. Ann. § 169.14 subd. 10 (West Supp. 1979); Miss. Code Ann. § 63-3-519 (1973 & Supp. 1979); Mont. Code Ann. § 61-8-702 (1979); Neb. Rev. Stat. § 39-664 (1978); N.D. Cent. Code § 39-03-15 (1980); Ohio Rev. Code Ann. § 4511.091 (Page 1973); Okla. Stat. Ann. tit. 47, § 16-114 (West Supp. 1979); Pa. Stat. Ann. tit. 75, § 3368(c) (Purdon 1977); Va. Code § 46.1-198 (1974); W. Va. Code § 17C-6-7 (1974).

77. *See, e.g.*, *United States v. Dreos*, 156 F. Supp. 200, 208 (D. Md. 1957); *Thomas v. City of Norfolk*, 207 Va. 12, 15, 147 S.E.2d 727, 729 (1966); *Royals v. Commonwealth*, 198 Va. 876, 881, 96 S.E.2d 812, 815-16 (1957).

B. Accuracy

1. Legal Standards

Although the courts have traditionally taken judicial notice of the general reliability of radar units,⁷⁸ it must nevertheless be proven that the particular radar device used to detect an alleged speeding violation was operating accurately.⁷⁹ Accuracy "is the ability to measure a phenomenon within a given tolerance level or margin of error."⁸⁰ There is a split of judicial authority regarding whether the accuracy of a particular device should affect the admissibility of the radar evidence or merely its sufficiency.⁸¹ Eleven states seem to favor the view that radar readings are inadmissible unless the particular radar unit's accuracy is shown by reasonable proof.⁸² In contrast,

78. See notes 70-77 *supra* and accompanying text.

79. E.g., *People v. MacLaird*, 264 Cal. App. 972, 973, 71 Cal. Rptr. 191, 191-92 (1968); *State v. Tomanelli*, 153 Conn. 365, 371, 216 A.2d 625, 629 (1966); *People v. Abdallah*, 82 Ill. App. 2d 312, 316, 226 N.E.2d 408, 410 (1967); *Commonwealth v. Whynaught*, — Mass. —, —, 384 N.E.2d 1212, 1215 (1979); *State v. Gerdes*, 291 Minn. 353, 359, 191 N.W.2d 428, 432 (1971); *State v. Graham*, 322 S.W.2d 188, 196-97 (Mo. Ct. App. 1959); *State v. Dantonio*, 18 N.J. 570, 578, 115 A.2d 35, 40 (1955); *State v. Readding*, 160 N.J. Super. 238, 240-41, 389 A.2d 512, 513-14 (Super. Ct. Law Div. 1978); *State v. Overton*, 135 N.J. Super. 443, 445-46, 343 A.2d 516, 517 (Sussex County Ct. 1975); *People v. Magri*, 3 N.Y.2d 562, 566, 147 N.E.2d 728, 731, 170 N.Y.S.2d 335, 338 (1958); *People v. Cunha*, 93 Misc. 2d 467, 468-69, 402 N.Y.S.2d 925, 926 (Nassau County Dist. Ct.), *aff'd*, 96 Misc. 2d 522, 409 N.Y.S.2d 387 (Sup. Ct. App. Term 1978); *City of E. Cleve. v. Ferrell*, 168 Ohio St. 298, 303, 154 N.E.2d 630, 633 (1958).

80. *Latin, Tannehill & White, supra* note 2, at 1384.

81. Compare *State v. Tomanelli*, 153 Conn. 365, 371, 216 A.2d 625, 629 (1966) and *State v. Readding*, 160 N.J. Super. 238, 240, 389 A.2d 512, 513 (Super. Ct. Law Div. 1978) with *People v. Dusing*, 5 N.Y.2d 126, 128, 155 N.E.2d 393, 394, 181 N.Y.S.2d 493, 495 (1959) and *State v. Bonar*, 40 Ohio App. 2d 360, 363, 319 N.E.2d 388, 390 (1973).

82. See *Everight v. Little Rock*, 230 Ark. 695, 326 S.W.2d 796 (1959); *People v. Flaxman*, 74 Cal. App. 3d Supp. 16, 141 Cal. Rptr. 799 (1977); *State v. Tomanelli*, 153 Conn. 365, 216 A.2d 625 (1966); *Honeycutt v. Commonwealth*, 408 S.W.2d 421 (Ky. 1966); *Commonwealth v. Whynaught*, — Mass. —, 384 N.E.2d 1212 (1979); *State v. Graham*, 322 S.W.2d 188 (Mo. Ct. App. 1959); *Peterson v. State*, 163 Neb. 669, 80 N.W.2d 688 (1957); *State v. Dantonio*, 18 N.J. 570, 115 A.2d 35 (1955); *Hardaway v. State*, 202 Tenn. 94, 302 S.W.2d 351 (1957); *Masquelette v. State*, 579 S.W.2d 478 (Tex. Crim. App. 1979); *State v. Doria*, 135 Vt. 341, 376 A.2d 751 (1977). In *Whynaught*, the court recognized this rule, but affirmed a conviction for speeding despite the improper testing of the radar device because the officer's testimony corroborated the radar reading. The defendant had been found to be greatly exceeding the speed limit. Thus, to uphold the speeding conviction was "consistent with fairness and justice." — Mass. at —, 384 N.E.2d at 1216 (citations omitted). The court noted that in the future, however, it would require that radar devices be tested to admit readings from the devices into evidence, unless there was independent corroborative testimony. See also *State v. Bollinger*, 550 S.W.2d 214 (Mo. Ct. App. 1977). The Missouri courts adopt a particularly strict view of radar evidence admissibility. Not only must the radar device be tested, but the test instruments themselves must be shown to be accurate, even when several different tests were performed with consistent results. In *Bollinger*, the police officer checked the radar device with a tuning fork and with an internal calibration device (a testing circuit built into the radar speedometer) with accurate and consistent results. The accuracy of the tuning fork and internal calibration device, however, could not be shown, with the result that the evidence was ruled inadmissible. *Id.* at 215; accord, *City of Ballwin v. Collins*,

seven states, including New York, have expressly held that readings from an untested radar speedmeter are admissible, and the fact that the unit is untested only affects the weight and sufficiency of the evidence.⁸³ Absent proof of accuracy, the radar evidence alone is insufficient to support a conviction, even though it is admissible as some evidence of a violation. "[T]he resulting deficiency in proof can be supplied by the testimony of qualified observers."⁸⁴ Thus, the evidence is sufficient to convict if a police officer, qualified to estimate vehicle speeds visually, offers corroborating testimony.⁸⁵ Furthermore, if the radar unit has been properly tested, the radar evidence alone may be sufficient to convict.⁸⁶

534 S.W.2d 280, 280-81 (Mo. Ct. App. 1976). *See also* *Kansas City v. Hill*, 442 S.W.2d 89 (Mo. Ct. App. 1969); *St. Louis v. Boecker*, 370 S.W.2d 731 (Mo. Ct. App. 1963). *But cf.* *State v. Graham*, 322 S.W.2d 188, 197 (Mo. Ct. App. 1959) (radar evidence admissible because radar checked against untested speedometer and tuning fork which corroborated the radar evidence). Many courts have rejected the strict view. For example, in *State v. Snyder*, 184 Neb. 465, 466, 168 N.W.2d 530, 531 (1969), the defendant contended that the tuning fork and speedometer used to check the accuracy of the radar device would also have to be checked for accuracy. The court rejected this argument, because such tests might "have to proceed ad infinitum." *See State v. Overton*, 135 N.J. Super. 443, 447-48, 343 A.2d 516, 518 (Sussex County Ct. 1975); *People v. Lynch*, 61 Misc. 2d 117, 120, 304 N.Y.S.2d 985, 987 (Tompkins County Ct. 1969); *People v. Stephens*, 52 Misc. 2d 1070, 1072, 227 N.Y.S.2d 567, 569 (Yates County Ct. 1967); *State v. Sprague*, 113 R.I. 351, 357-58, 322 A.2d 36, 39-40 (1974).

83. *See People v. Abdallah*, 82 Ill. App. 2d 312, 226 N.E.2d 408 (1967); *State v. Shimon*, 243 N.W.2d 571 (Iowa 1976); *State v. Gerdes*, 291 Minn. 353, 191 N.W.2d 428 (1971); *People v. Dusing*, 5 N.Y.2d 126, 155 N.E.2d 393, 181 N.Y.S.2d 493 (1959); *State v. Bonar*, 40 Ohio App. 2d 360, 319 N.E.2d 388 (1973); *State v. Sprague*, 113 R.I. 351, 322 A.2d 36 (1974); *State v. Hanson*, 85 Wis. 2d 233, 270 N.W.2d 212 (1978). In *State v. Shimon*, 243 N.W.2d 571 (Iowa 1976), the court upheld a conviction for speeding when defendant's car was recorded at 94 mph in a 55 mph zone, even though the radar device was arguably improperly tested. The court adopted the New York view, holding that improper testing "goes more to the weight and sufficiency of the evidence than to its admissibility." *Id.* at 573. It is clear, however, that when there is independent evidence that the defendant was significantly exceeding the speed limit, a conviction will be upheld in either a "sufficiency" or "admissibility" jurisdiction. *See Commonwealth v. Whynaught*, — Mass. —, 384 N.E.2d 1212 (1979); *People v. Cunha*, 93 Misc. 2d 467, 402 N.Y.S.2d 925 (Nassau County Dist. Ct.), *aff'd*, 96 Misc. 2d 522, 409 N.Y.S.2d 387 (App. Term 1978). "[P]roperly qualified testimony of a witness is sufficient by itself to convict a defendant where the difference between the estimate and the speed limit was at a substantial variance" *Id.* at 469, 402 N.Y.S.2d at 926 (citations omitted).

84. *People v. Dusing*, 5 N.Y.2d 126, 128, 155 N.E.2d 393, 394, 181 N.Y.S.2d 493, 495 (1959).

85. *See, e.g., People v. Magri*, 3 N.Y.2d 562, 567, 147 N.E.2d 728, 731, 170 N.Y.S.2d 335, 339 (1958); *People v. Cunha*, 93 Misc. 2d 467, 469, 402 N.Y.S.2d 925, 926 (Nassau County Dist. Ct.), *aff'd*, 96 Misc. 2d 522, 409 N.Y.S.2d 387 (App. Term 1978); *People v. Perlman*, 89 Misc. 2d 973, 392 N.Y.S.2d 985 (Suffolk County Dist. Ct. 1977). In *Perlman*, evidence of accuracy was insufficient to convict even though a police officer corroborated radar evidence of the defendant's speed. The testimony was rejected because the officer had only viewed defendant's car through his rear view mirror. *Id.* at 980-81, 392 N.Y.S.2d at 991.

86. *E.g., People v. Dusing*, 5 N.Y.2d 126, 128, 155 N.E.2d 393, 394, 181 N.Y.S.2d 493, 496 (1959); *People v. Stephens*, 52 Misc. 2d 1070, 1072, 277 N.Y.S.2d 567, 569 (Yates County Ct. 1967); *People v. Martirano*, 52 Misc. 2d 64, 65, 275 N.Y.S.2d 215, 217 (Westchester County Ct. 1966); *accord, People v. Abdallah*, 82 Ill. App. 2d 312, 316, 226 N.E.2d 408, 410 (1967), *State v.*

State legislatures have also attempted to deal with the question of radar accuracy. Five states make radar measurements *prima facie* evidence of the speed of defendant's vehicle,⁸⁷ while two others provide that certificates of accuracy are presumptive⁸⁸ or *prima facie* evidence⁸⁹ of the radar device's accuracy. Four states provide that the radar device must be tested for accuracy at specified times.⁹⁰ Recognizing the utility of radar for law enforcement, but acknowledging the possibility for error, two states provide that no conviction will be sustained unless the measured speed exceeds the speed limit by a certain amount.⁹¹ Additionally, one state has recently provided that radar measurements are admissible in evidence subject to a showing that the radar device was operated with minimal distortion or interference from outside sources.⁹² Although the ultimate burden of proof of accuracy is still on the prosecution,⁹³ in those states in which radar measurements are *prima facie* evidence of speed or carry a presumption of accuracy, the practical effect is to establish the accuracy of the radar device conclusively when the defendant cannot offer rebuttal evidence that the device was inaccurate.⁹⁴ It is unlikely, however, that many defendants will challenge a speeding violation considering the disparity between the fine that is imposed and the costs of producing expert and documentary evidence of inaccuracy.⁹⁵ As one court has

Shimon, 243 N.W.2d 571, 573 (Iowa 1976); *State v. Bonar*, 40 Ohio App. 2d 360, 363, 319 N.E.2d 388, 390 (1973).

87. Me. Rev. Stat. Ann. tit. 29, § 1254 (1965 & West Supp. 1977); Neb. Rev. Stat. § 39-664 (1978); N.D. Cent. Code § 39-03-15 (1980); Va. Code § 46.1-198 (1974); W. Va. Code § 17C-6-7 (1974).

88. Fla. Stat. Ann. § 316.1905 (3)(b) (West Supp. 1978).

89. Pa. Stat. Ann. tit. 75, § 3368(d) (Purdon 1977).

90. Fla. Stat. Ann. § 316.1905(1) (West Supp. 1978) (once every six months); Ga. Code Ann. § 68-2101(c)(1) (Supp. 1979) (beginning and end of each tour of duty); Minn. Stat. Ann. § 169.14 subd. 10(d) (West Supp. 1979) (at time the device was set up); Pa. Stat. Ann. tit. 75, § 3368(d) (Purdon 1977) (within 60 days prior to alleged violation).

91. Ga. Code Ann. § 68-2101(a) (Supp. 1979) (10 mph above speed limit); Pa. Stat. Ann. tit. 75, § 3368(c)(2) (Purdon 1977) (six mph above speed limit).

92. Minn. Stat. Ann. § 169.14 subd. 10(c) (West Supp. 1979).

93. *E.g.*, *State v. Snyder*, 184 Neb. 465, 168 N.W.2d 530 (1969); *Thomas v. City of Norfolk*, 207 Va. 12, 14-15, 147 S.E.2d 727, 729 (1966); *Royals v. Commonwealth*, 198 Va. 876, 881, 96 S.E.2d 812, 816 (1957). The statute "does not eliminate the necessity for the [state] to prove that the machine . . . had been properly set up and recently tested for accuracy." *Id.*; see Fla. Stat. Ann. § 316.1905 (3)(b) (West Supp. 1978) ("Upon the production of a certificate . . . showing that [the] device was tested within the time period specified and that such device was working properly, a presumption is established to that effect unless the contrary shall be established by competent evidence."); A. Moenssens, R. Moses & F. Inbau, *supra* note 69, § 13.08, at 534; W. Richardson, *Evidence* § 96, at 71-72 (10th ed. J. Prince 1973). *But see Commonwealth v. Perdok*, 411 Pa. 301, 305, 192 A.2d 221, 224 (1963) ("Since this document is *prima facie* evidence of the accuracy of the machine, the burden of proof was upon appellant to establish that it was not accurate.").

94. *E.g.*, *Commonwealth v. Perdok*, 411 Pa. 301, 305, 192 A.2d 221, 224 (1963); *Thomas v. City of Norfolk*, 207 Va. 12, 16, 147 S.E.2d 727, 730 (1966); *Uniform Act*, *supra* note 53, at 449.

95. For example, *Electrolert, Inc.*, a manufacturer of microwave detection devices that are used to alert motorists that radar is being used by police in their vicinity, paid the fees and expenses of expert witnesses who testified at the hearings leading to the decision in *State v. Aquilera*, 48 Fla. Supp. 207 (Dade County Ct. 1979). *N.Y. Times*, May 8, 1979, § A, at 16, col.

recently stated "no single defendant can afford the tremendous cost in money and time to produce such a defense to a speeding charge."⁹⁶

2. Testing Methods

There are four different testing methods used to ascertain the accuracy of radar speedometers.⁹⁷ A common method is to utilize a test car with a calibrated speedometer.⁹⁸ The test car's speedometer reading is compared to the reading on the radar device for accuracy as the car passes through the radar's zone of influence.⁹⁹ Another commonly used method is to strike a tuning fork calibrated to oscillate at a frequency corresponding to the Doppler shift for a given speed reading.¹⁰⁰ The vibrating tuning fork is then held near the radar unit's antenna and the resulting speed reading is compared to the proper reading for that particular tuning fork.¹⁰¹ A third method is to activate an integral oscillator within the radar unit, that should display a certain speed reading on the speedometer's output display.¹⁰² A final method involves periodic calibration by laboratory technicians using sophisticated equipment.¹⁰³

4. The company is reported to have spent \$20,000 on the case. 82 *New Scientist* 1070 (June 28, 1979).

96. *State v. Aquilera*, 48 Fla. Supp. 207, 208 (Dade County Ct. 1979).

97. *E.g.*, *State v. Readding*, 160 N.J. Super. 238, 241, 389 A.2d 512, 514 (Super. Ct. Law Div. 1978) (describing the three operator performed tests); *City of E. Cleve. v. Ferrell*, 168 Ohio St. 298, 303, 154 N.E.2d 630, 633 (1958) (describing the fourth test); *see C. McCormick, supra* note 69, at 515; A. Moenssens, R. Moses & F. Inbau, *supra* note 69, § 13.09, at 534-36.

98. *See, e.g.*, *Honeycutt v. Commonwealth*, 408 S.W.2d 421, 423 (Ky. Ct. App. 1966); *State v. Graham*, 322 S.W.2d 188, 197 (Mo. Ct. App. 1959); *City of E. Cleve. v. Ferrell*, 168 Ohio St. 298, 303, 154 N.E.2d 630, 633 (1958).

99. *See Kopper, supra* note 9, at 353 (description of the speedometer drive-through test).

100. *E.g.*, *State v. Tomanelli*, 153 Conn. 365, 372, 216 A.2d 625, 630 (1966); *State v. Naumec*, 3 Conn. Cir. Ct. 575, 576, 222 A.2d 239, 240 (1966); *People v. Abdallah*, 82 Ill. App. 2d 312, 314, 226 N.E.2d 408, 409 (1967); *State v. McDonough*, 302 Minn. 468, 470, 225 N.W.2d 259, 260 (1975) (per curiam); *Kansas City v. Hill*, 442 S.W.2d 89, 92 (Mo. Ct. App. 1969); *People v. Cunha*, 93 Misc. 2d 467, 468, 402 N.Y.S.2d 925, 926 (Nassau County Dist. Ct.), *aff'd*, 96 Misc. 2d 522, 409 N.Y.S.2d 387 (App. Term 1978).

101. *See Highway District Radar Manual, supra* note 17, at 2-4. The tuning fork is used in the following manner: "Strike the tuning fork . . . on a hard NON-METALLIC surface such as the heel of a boot. Hold the fork about one (1) inch in front of the antenna face, making sure that the 'U' of the fork is not facing the antenna but rather facing sideways. . . . The readout should read [plus] or [minus] 1 mph the reading stamped on the tuning fork. If the proper reading is not obtained, the system should immediately be taken out of service." *Id.* at 4.

102. *E.g.*, *Commonwealth v. Whynaught*, — Mass. —, —, 384 N.E.2d 1212, 1213-14 (1979); *State v. Gerdes*, 291 Minn. 353, 354, 360, 191 N.W.2d 428, 429, 433 (1971); *see A. Moenssens, R. Moses & F. Inbau, supra* note 69, § 13.09, at 534-35. The internal calibration test is performed in the following manner: "Place the function dial to the [calibrate] position, and . . . depress the calibrate button. . . . The [radar device] should immediately read 65 MPH. If the unit reads out any other speed, allowing for a one (1) mile tolerance either above or below 65 MPH, the unit has malfunctioned and should immediately be taken out of service. . . ." *Highway District Radar Manual, supra* note 17, at 4.

103. *See, e.g.*, *City of E. Cleve. v. Ferrell*, 168 Ohio St. 298, 303, 154 N.E.2d 630, 633 (1958); A. Moenssens, R. Moses & F. Inbau, *supra* note 69, § 13.09, at 534.

There appears to be no consensus as to which test or combination of tests is required, either for admissibility or sufficiency.¹⁰⁴ Some courts have explicitly held that testing solely by means of an internal calibration device does not suffice.¹⁰⁵ Several courts also hold that the accuracy of the testing devices must be shown even when "comparative analyses"¹⁰⁶ using a combination of accuracy testing methods are used. Thus, for example, when a police officer checked a radar device using a tuning fork, speedometer, and internal calibration test, but could not prove the accuracy of each testing device, the evidence was inadmissible.¹⁰⁷

C. Operation and Operator Qualifications

One of the factors that has contributed to the widespread use of radar by law enforcement agencies is its convenient and simple operation which allows for relatively short training periods for radar operators.¹⁰⁸ The courts tradi-

104. See, e.g., *Commonwealth v. Whynaught*, — Mass. —, —, 384 N.E.2d 1212, 1215 (1979) (appellate court refused to set guidelines as to what tests are appropriate, leaving the issue to the trial court's discretion); *State v. McDonough*, 302 Minn. 468, 470, 225 N.W.2d 259, 260 (1975) (external tuning fork and internal test found sufficient); *City of Ballwin v. Collins*, 534 S.W.2d 280, 281 (Mo. Ct. App. 1976) (speedometer, tuning fork, and internal test found insufficient because none of the devices were checked for accuracy); *State v. Readding*, 160 N.J. 238, 241-42, 389 A.2d 512, 514-15 (Super. Ct. Law Div. 1978) (check by single tuning fork found insufficient); *State v. Sprague*, 113 R.I. 351, 357-58, 322 A.2d 36, 39-40 (1974) (single tuning fork sufficient).

105. E.g., *State v. Gerdes*, 291 Minn. 353, 358-59, 191 N.W.2d 428, 431-32 (1971); *State v. Overton*, 135 N.J. Super. 443, 446, 343 A.2d 516, 517 (Sussex County Ct. 1975); *People v. Perlman*, 89 Misc. 2d 973, 978-80, 392 N.Y.S.2d 985, 990 (Suffolk County Dist. Ct. 1977). But see *People v. Maniscalco*, 94 Misc. 2d 915, 405 N.Y.S.2d 888 (North Castle J. Ct. 1978). In *Perlman*, the radar device had been tested by an external tuning fork and an internal test at the beginning of the officer's tour of duty. 89 Misc. 2d at 975, 392 N.Y.S.2d at 987-88. At each subsequent set-up of the radar device at different locations during the day, however, the device was only tested by means of an internal test. *Id.* The court found this means of testing insufficient to establish the accuracy of the radar device without expert testimony concerning the reliability of the internal testing device. *Id.* at 979, 392 N.Y.S.2d at 990. In contrast, in *Maniscalco*, the court approved similar testing methods, finding that there is a "history of general reliability of this radar" and the tests used to check it "developed through court usage and acceptance." 94 Misc. 2d at 918, 405 N.Y.S.2d at 890 (quoting *Perlman*); see *Commonwealth v. Whynaught*, — Mass. —, —, 384 N.E.2d 1212, 1216 n.6 (1979) (validity of internal test left to consideration of trial court). In *Whynaught*, the officer used only an internal test to check accuracy. The court upheld the conviction, although reluctantly, because of the great disparity between the speed limit and defendant's clocked speed. Additionally, the officer was able to provide independent corroborating testimony. *Id.* at —, 384 N.E.2d at 1216.

106. *People v. Stephens*, 52 Misc. 2d 1070, 1072, 277 N.Y.S.2d 567, 569 (Yates County Ct. 1967); see note 82 *supra*.

107. *City of Ballwin v. Collins*, 534 S.W.2d 280, 281 (Mo. Ct. App. 1976); see note 82 *supra*.

108. See *Field Operational Characteristics*, *supra* note 18, at 12. Typical "radar training varies from only a few days of classroom training to several weeks of on-the-job training." *Id.* at 6; see *Police Traffic Radar*, *supra* note 4, at 1 ("[O]perator training requirements . . . range from less than one hour to several days.") Compare this training to that required for VASCAR certification, which is approximately sixty hours of instruction. *Id.* at 6, 13. Dr. Kopper wrote that one and one-half to two hours of instruction are sufficient for radar operation. Kopper, *supra* note 9, at 353. In *State v. Schmiede*, 118 N.J. Super. 576, 289 A.2d 281 (Somerset County Ct. 1972), the officer using VASCAR had received one full day's training from a qualified operator, followed by

tionally have neither scrutinized operator qualifications, nor the proper operation of the particular radar device at the time of the alleged violation. Furthermore, they have approved of short training sessions¹⁰⁹ which are typically conducted by the radar speedmeter manufacturers or police departments.¹¹⁰ The completion of such a training program given by qualified instructors is generally sufficient to demonstrate proper qualifications to operate the device and permit admission of the radar evidence.¹¹¹ Most courts agree that the operator of the radar device need not be an electrical engineer or have an intricate understanding of the components of radar.¹¹² It appears that all that is necessary for admissibility is that the radar operator be familiar with the device and its operation.¹¹³ Proper operation of the device is usually evidenced by the operator's testimony including detailed reference to the procedure recommended by the manufacturer of the radar device.¹¹⁴

one month's practice use of the device. This was followed by a series of 30 rigorous tests before the officer was certified. *Id.* at 580-81, 289 A.2d at 283. Typical operation of modern radar devices involves only one officer and patrol car. The officer performs the dual functions of operating the device and pursuing the violator. *See* *People v. Perlman*, 89 Misc. 2d 973, 977, 392 N.Y.S.2d 985, 989 (Suffolk County Dist. Ct. 1977); *Field Operational Characteristics*, *supra* note 18, at 3. Operation of older devices generally required two officers and two patrol cars. The radar device was located in one car and when a speed violation occurred, the operator would radio another officer in a pursuit car stationed a distance away to apprehend the violator. *See* 11 Am. Jur. *Proof of Facts*, Proof No. 3, at 30 (Supp. 1979) (description of early radar operation techniques).

109. *See, e.g.*, *State v. Graham*, 322 S.W.2d 188, 196 (Mo. Ct. App. 1959) (one and a half hours instruction approved); *State v. Musgrave*, 169 N.J. Super. 204, 208, 404 A.2d 650, 653 (Super. Ct. Law Div. 1979) (one or two hours and two weeks on road with experienced operator); *City of E. Cleve. v. Ferrell*, 168 Ohio St. 298, 303-04, 154 N.E.2d 630, 633 (1958) ("[T]he officer . . . is merely required to read the dial on the meter. . . . A police officer with five years of experience is certainly qualified to do that.")

110. *Field Operational Characteristics*, *supra* note 18, at 6.

111. *See* *State v. Tomanelli*, 153 Conn. 365, 371-72, 216 A.2d 625, 630 (1966); *State v. Harper*, 382 A.2d 263, 264 (Del. Super. Ct. 1978); *People v. Stankovich*, 119 Ill. App. 2d 187, 193, 255 N.E.2d 461, 464 (1970); *State v. Graham*, 322 S.W.2d 188, 195, 196 (Mo. Ct. App. 1959); *State v. Readding*, 160 N.J. Super. 238, 243, 389 A.2d 512, 515 (Super. Ct. Law Div. 1978). It seems that some courts view the matter of operator qualification as only affecting sufficiency of radar evidence to convict the defendant. *E.g.*, *State v. McDonough*, 302 Minn. 468, 469-70, 225 N.W.2d 259, 260 (1975); *State v. Gerdes*, 291 Minn. 353, 359, 191 N.W.2d 428, 432 (1971); *State v. Hanson*, 85 Wis. 2d 233, 245, 270 N.W.2d 212, 218 (1978); *see* *Survey, The Minnesota Supreme Court 1971-1972*, 57 Minn. L. Rev. 881, 928 (1973). It is clear, however, that at least in Minnesota, radar evidence is now inadmissible without a showing of proper operator qualifications. *See* Minn. Stat. Ann. § 169.14 subd. 10(a) (West Supp. 1979).

112. *E.g.*, *State v. Tomanelli*, 153 Conn. 365, 371-72, 216 A.2d 625, 630 (1966); *People v. Abdallah*, 82 Ill. App. 2d 312, 317, 226 N.E.2d 408, 411 (1967); *State v. Graham*, 322 S.W.2d 188, 196 (Mo. App. Ct. 1959); *State v. Dantonio*, 18 N.J. 570, 578-79, 115 A.2d 35, 40 (1955).

113. *People v. Flaxman*, 74 Cal. App. 3d Supp. 16, 23-24, 141 Cal. Rptr. 799, 803-04 (1977); *People v. Abdallah*, 82 Ill. App. 2d 312, 317, 226 N.E.2d 408, 411 (1967); *State v. Dantonio*, 18 N.J. 570, 579-80, 115 A.2d 35, 40 (1955).

114. *See, e.g.*, *State v. Readding*, 160 N.J. Super. 238, 244, 389 A.2d 512, 515 (Super. Ct. Law Div. 1978); 11 Am. Jur. *Proof of Facts*, Proof No. 3, at 26-51 (Supp. 1979) (describing method of cross-examining radar operator).

D. Recent Evidentiary Determinations

The traditional criteria for determining the admissibility and sufficiency of radar evidence have been questioned by the courts in recent cases. The reliability problems that have been encountered have raised a serious challenge to the basic concepts of the foundation for radar evidence.

In *State v. Aquilera*,¹¹⁵ a controversial and highly publicized case,¹¹⁶ a Florida county court ruled that "radar speed measuring devices as used in their present modes" may not be offered as evidence in speeding violation cases.¹¹⁷ The court recognized that although "many millions of dollars in revenue are involved in 'speeding' fines . . . the function of the traffic court is to convict the guilty, acquit the innocent, and improve traffic safety, but not to be merely an arm of any revenue collection office."¹¹⁸ In deciding whether to admit radar evidence, the court weighed voluminous documentary studies, expert testimony, and exhibits by "highly trained and experienced specialists."¹¹⁹ On the basis of this evidence, the court determined that technical

115. 48 Fla. Supp. 207 (Dade County Ct. 1979). This case was a consolidation of over 80 speeding cases. The court noted that "[a]lthough there have been a few challenges to radar readings in other courts, [this] case of first impression . . . is the first time that any court has been presented so much testimony and so many exhibits from so many highly qualified experts . . . from all parts of the country." *Id.* at 208.

116. See Police Traffic Radar, *supra* note 4, at 1; 82 New Scientist 1070 (June 28, 1979); 82 New Scientist 526 (May 17, 1979); N.Y. Times, Mar. 7, 1980, § A, at 16, col. 6; *id.*, Nov. 27, 1979, § C, at 1, col. 3; *id.*, Nov. 14, 1979, § B, at 2, col. 3; *id.*, May 17, 1979 § A, at 16, col. 5; *id.*, May 14, 1979, § A, at 18, col. 1; *id.*, May 9, 1979, § A, at 22, col. 4; *id.*, May 8, 1979, § A, at 16, col. 4; *id.*, Apr. 19, 1979, § A, at 16, col. 1; Wall St. J., May 8, 1979, at 16, col. 2; *Radar on Trial*, Prime Time Saturday, Nat'l Broadcasting Co., Mar. 8, 1980 (television broadcast). It is estimated that the media has informed 300 million persons of the court's decision in *Aquilera*. See 82 New Scientist 1070 (June 28, 1979).

117. 48 Fla. Supp. at 210.

118. *Id.* at 209. The court was concerned that radar devices were used merely to earn revenue rather than to serve the legitimate purpose of speed limit enforcement. *Id.* That radar may be misused in this regard is evident from several sources. See, e.g., N.Y. Times, Apr. 19, 1979 § A, at 16, col. 1 (small town in West Virginia reported to have hired two part-time police officers to patrol a designated 35 mph speed zone; the town divides the revenue from speeding fines with the policemen); *id.*, Apr. 6, 1980, § 10, at 9, col. 1 (motorists advised to drive carefully when out of state "because the police there know [motorists] are more likely to plead guilty than go to the trouble of returning for a court appearance."). The legislature of Georgia has been especially concerned with misuse of radar, and has provided for the revocation of radar use permits if municipalities are found to be employing radar "for purposes other than promotion of the public health, welfare, and safety." Ga. Code Ann. §§ 68-2108 to -2111 (Supp. 1979). It is estimated that 28,000 motorists are convicted of speeding violations every day in the United States. 82 New Scientist 1070 (June 28, 1979). In New York, for example, 602,122 speeding convictions were obtained in 1978, nearly 50% of all traffic-related offenses. New York State Dep't of Motor Vehicles—Div. of Research and Development, *Convictions 1978* (May 29, 1979); New York State Dep't of Motor Vehicles, Office of Public Information, *DMV News* (May 29, 1979). A conservative estimate, assuming the average fine to be \$20.00, yields over \$12 million in state revenue for 1978.

119. 48 Fla. Supp. at 208. The court "heard over two thousand pages of testimony and arguments, . . . examined thirty-three exhibits presented by . . . specialists in the fields of mathematics, electrical engineering, and the design, construction and testing of radar devices." *Id.*

errors such as cosine error, batching, shadowing, external interference, and reliance on the automatic lock system, undermined the reliability of radar to detect speeding violations.¹²⁰ Although it admitted that "these problems are minimal in degree," the court found that they are intensified by the absence of "highly skilled radar operator[s]."¹²¹ Therefore, the state had neither "established [the reliability of radar devices] beyond and to the exclusion of every reasonable doubt, nor ha[d] it met the test of reasonable scientific certainty."¹²² Thus, even though it did not dispute the acceptability of the general scientific principles of radar, the court would neither take judicial notice of the general reliability of police speed radar devices nor admit the radar measurements into evidence.¹²³

In contrast, in *State v. Wojtkowiak*,¹²⁴ after considering substantially the same evidence, the Superior Court of New Jersey determined that a modern form of radar had a "high degree of scientific and operational reliability when used in either stationary or moving mode."¹²⁵ The court first reviewed the general scientific merits of the Doppler effect and their application to a

120. *Id.* at 209-10. The court stated that radar devices "can and should be improved to the extent that they are accurate and identification of the target vehicles can be readily made, under any conditions. Undoubtedly, the manufacturers with their scientific and financial resources can accomplish this in the very near future." *Id.* at 208. Although the assumption that radar devices can be made accurate "under any conditions" is a tenuous one, the court noted that the "prime inhibition against [improvement] is . . . that [government purchasing agents] place economy ahead of quality." *Id.* The court questioned "a strange profit structure" (purchase price of radar devices reduced from \$2,500 to \$375 per unit for large quantity purchases), and suggested the implementation of a "central purchasing office on the state level for radar units so that advantage can be taken of such substantial reductions. . . . [T]he savings [from such a program] would offset the increased cost of the improved product." *Id.* at 209.

121. *Id.* at 210. The court noted, however, that "intensive course[s] of training" for radar operators "would only [result in] a lessening of the problems." *Id.*

122. *Id.* The court seems to have applied a double standard. Although conceding that some of the errors "were minimal in degree," and that the test was one of "reasonable scientific certainty," the court urged that radar devices should be improved so that "exact identification [would be] assured under any conditions." *Id.* at 209-10. This is a contradiction in terms, because any test of "reasonable scientific certainty" would acknowledge that a scientific device cannot be accurate under all conditions. See, e.g., *State v. Wojtkowiak*, 170 N.J. Super. 44, 60, 405 A.2d 477, 485 (Super. Ct. Law Div. 1979) ("Absolute perfection . . . is not required."); *Commonwealth v. Perdok*, 411 Pa. 301, 305, 192 A.2d 221, 224 (1963) ("[T]he legislature did not require absolute exactness since no machine is capable of such precise measurement.").

123. 48 Fla. Supp. at 208, 210. Although the court noted that "the reliability of the radar speed measuring devices as used in their present modes and particularly in these cases, has not been established beyond and to the exclusion of every reasonable doubt," it did not limit its holding to the radar devices examined at the hearing. *Id.* at 210; see *Police Traffic Radar*, *supra* note 4, at 1-2. Six different types of radar devices were examined in the Florida hearings. *Interim Report*, in *Police Traffic Radar*, *supra* note 4, at iii.

124. 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979)

125. 170 N.J. Super. at 63, 405 A.2d at 487. In this case, the court determined the scientific reliability of the MPH Industries K55 moving radar device. Its conclusion was limited to the use of the device in the "manual" mode. The court found that "[w]hen operated in the automatic position [the automatic lock feature] the operational reliability of the K55 is subject to greater question, and acceptance of [radar] readings while in that position must hinge to a far greater extent on detailed examination of the surrounding circumstances as well as the experience and training of the operator." *Id.* at 63, 405 A.2d at 487; see note 65 *supra*.

particular modern radar device.¹²⁶ In addition, the court considered testimony of a state trooper and several "highly experienced technician[s] in the field of electronic circuits."¹²⁷ Although there was conflicting testimony regarding the accuracy and testing methods of the particular device, the court was satisfied that such testimony did not "raise a reasonable doubt as to the technical capability" of the radar device.¹²⁸ The court recognized the practical and theoretical difficulties of "target identification in the multiple-lane, heavy traffic situation"¹²⁹ and the possibilities of "spurious readings,"¹³⁰ yet stated that an alert operator could minimize these problems or "reject any target speeds obtained in that situation."¹³¹ Thus, conceding that "[e]very law enforcement tool, whether it be a radar set or a bloodhound, must be understood and used within its inherent limitations," the court concluded that radar evidence is admissible in speed violation cases.¹³²

In a third case, *State v. Hanson*,¹³³ the Supreme Court of Wisconsin attempted to reconcile the conflicting opinions regarding the accuracy and reliability of speed radar devices. The court seemed to agree with a lower court's decision not to take judicial notice of the reliability of a particular moving radar device, although it accepted judicial notice of the underlying scientific principles of radar.¹³⁴ Accordingly, the court explicitly sanctioned

126. *Id.* at 48-54, 405 A.2d at 479-82.

127. *Id.* at 46-47, 54, 405 A.2d at 479, 482-85. The court considered the testimony of four expert witnesses including the manufacturer's vice-president, who had an extensive engineering background, *see State v. Musgrave*, 169 N.J. Super. 204, 205, 404 A.2d 650, 651-52 (Super. Ct. Law Div. 1979), a non-degreed engineer with an equally extensive practical background in electronics circuitry design, a highly experienced technician who owned a traffic radar repair business, and an electrical engineer with a Ph.D. degree who taught microwave theory and techniques at an engineering college. 170 N.J. Super. at 46-48, 54-56, 405 A.2d at 479, 482-83.

128. *Id.* at 55, 405 A.2d at 483.

129. *Id.* at 60, 405 A.2d at 485.

130. *Id.*

131. *Id.* at 59, 405 A.2d at 485. The court suggested that "periodic follow-up training be instituted in order to verify continuing qualifications as a K55 operator." *Id.* at 63, 405 A.2d at 487.

132. *Id.* at 61-63, 405 A.2d at 486-87. The court compared the K55 radar device with "a well-trained bloodhound, who once given an example of the target scent, wants to, and can, filter out or discriminate between all the other distracting scents its nose senses and track the target scent." *Id.* at 53, 405 A.2d at 482. "[But,] like our bloodhound who cannot, having found the source of the scent, identify it as a vicious criminal or a lost child, so also cannot the K55 identify the speeding vehicle: the officer using it must do that." *Id.* at 62, 405 A.2d at 486. *See also State v. Fedje*, No. T-1979-725387MO (Dist. Ct. Hawaii Nov. 14, 1979). In *Fedje*, the court concluded that "when properly calibrated, placed and employed by trained police officers, [radar devices] will provide accurate and reliable measurements of vehicular speed." *Id.*, slip op. at 6. Additionally, the court noted that many of the errors attributable to radar devices were the result of intentional misuse, and therefore, "are not properly attributable to the instrument." *Id.* at 5.

133. 85 Wis. 2d 233, 270 N.W.2d 212 (1978).

134. "[W]hen the testimony of [the] experts is put against the testing standards of authoritative irrefutability, judicial notice should not have been taken." *Id.* at 242, 270 N.W.2d at 217. Yet, "[t]he courts of this state may take judicial notice of the reliability of the underlying principles of speed radar detection that employs the Doppler effect as a means of determining the speed of moving objects." *Id.* at 244, 270 N.W.2d at 218. This is no more than a restatement of the well-established rule that judicial notice "can extend . . . only to the scientific accuracy of the

the use of "a prima facie presumption of accuracy sufficient to support a speeding conviction," if certain operational guidelines are satisfied "by a competent, operating police officer."¹³⁵ The court believed that "these conditions to proving a prima facie speeding case [would not] place an onerous burden upon the law enforcement of speeding violators" but are necessary to maintain and improve public confidence in the judicial system.¹³⁶ These inconsistent results by courts that had the benefit of expert scientific testimony, underscore the need to establish guidelines for the introduction, admission, and sufficiency of radar evidence to improve upon the simple traditional foundation requirements.

IV. RECOMMENDATIONS

It is submitted that the mere possibility of error should not result in the exclusion of radar evidence; rather, the evidence should be admissible subject to the fulfillment of certain precautionary requirements for the protection of defendants. If the prosecution does not satisfy these guidelines, the evidence should be insufficient to convict, although it should nevertheless be admissible as relevant.¹³⁷

Two considerations should be balanced in any speeding violation prosecution: first, defendants must be treated fairly and should not be convicted if there is a reasonable doubt as to the reliability of the speed measurement;¹³⁸ second, the prosecution must not be burdened to the extent that proof by radar evidence becomes practically impossible.¹³⁹ Admittedly, speed radar evidence should not be conclusive, but should "merely constitut[e] admissible

Doppler-shift principle as a means of measuring speed if the principle is correctly applied. Judicial notice does not extend to the accuracy or efficiency of any given instrument designed to employ the principle." *State v. Tomanelli*, 153 Conn. 365, 371, 216 A.2d 625, 629 (1966). Thus, accuracy of the device in each particular case must be proven. See notes 78-96 *supra* and accompanying text. That the court did, in fact, take judicial notice of the general reliability of the moving radar device is made clear from the operational guidelines that the court established, and because expert testimony in future cases was not to be required. 85 Wis. 2d at 245-46, 270 N.W. 2d at 218-19; see notes 72-76 *supra* and accompanying text.

135. *Id.* at 245, 270 N.W.2d at 218-19. A prima facie presumption of accuracy sufficient to support a conviction was accorded to moving radar upon a showing that: the operator was qualified; the device was in proper working condition and tested according to suggested methods; it was used in an area where distortion was minimal; the patrol car speed as measured by the speedometer was verified; and, the speedometer was expertly tested following the arrest by means other than internal calibration. *Id.*

136. *Id.* at 245-46, 270 N.W.2d at 219.

137. This concept is analogous to the New York rule that the readings from an untested radar device are admissible, but are not without other evidence, sufficient to convict for a speeding violation. See notes 83-86 *supra* and accompanying text. "Where there is other evidence of speeding, the reading of an improperly tested radar meter should be admitted, since independent evidence of speeding serves as a check on the accuracy of the reading . . ." Survey, *The Minnesota Supreme Court 1971-1972*, 57 Minn. L. Rev. 881, 928 (1973); e.g., *State v. Gerdes*, 291 Minn. 353, 359, 191 N.W.2d 428, 432 (1971); *State v. Hanson*, 85 Wis. 2d 233, 245, 270 N.W.2d 212, 218-19 (1978).

138. See notes 67-68 *supra* and accompanying text.

139. E.g., *Commonwealth v. Whynaught*, — Mass. —, —, 384 N.E.2d 1212, 1216 (1979); *State v. Hanson*, 85 Wis. 2d 233, 245-46, 270 N.W.2d 212, 219 (1978).

evidence to be weighed by the trier of facts along with all other evidence which [is] logically relevant."¹⁴⁰ Nevertheless, such evidence can have a "heavy impact". . . on the factfinder."¹⁴¹ Therefore, the weight of radar evidence must be limited when the prosecution cannot establish that the radar device was operating free from sources of serious technical error. The proposed guidelines are in accordance with these policies and should be uniformly adopted to improve the evidentiary usage of radar devices.

A. Reliability

Because all radar speed measuring devices operate on the Doppler principle, which has been judicially noticed since 1955 as suitable for speed measurement,¹⁴² there should be no question as to the general reliability of radar speedmeters to measure speed accurately. Thus, in the case of moving radar,¹⁴³ which is basically a simple extension of the principles of stationary radar,¹⁴⁴ there should be no need for expert testimony regarding the principles and general reliability of the device to warrant admissibility.¹⁴⁵ Furthermore, when the reliability of an innovative radar device is contested, the prosecution should not be required to offer expert testimony if it can be shown that the particular device is of an accepted type operating on the Doppler principle.¹⁴⁶

140. *State v. Dantonio*, 18 N.J. 570, 580, 115 A.2d 35, 40 (1955); *accord*, *State v. Tomanelli*, 153 Conn. 365, 371, 216 A.2d 625, 629 (1966); *State v. Lenzen*, 1 Conn. Cir. 499, 504, 24 Conn. Supp. 208, 213, 189 A.2d 405, 407 (Cir. Ct. 1962); *People v. Dusing*, 5 N.Y.2d 126, 128, 155 N.E.2d 393, 394, 181 N.Y.S.2d 493, 495-96 (1959).

141. *State v. Readding*, 160 N.J. Super. 238, 243, 389 A.2d 512, 515 (Super. Ct. Law Div. 1978) (quoting *State v. Johnson*, 42 N.J. 146, 171, 199 A.2d 809, 823 (1964)).

142. See notes 3, 72-76 *supra* and accompanying text.

143. See notes 23, 32-35 *supra* and accompanying text.

144. In *State v. Wojtkowiak*, 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979), the court found that the moving radar "does not use any experimental, new or patentable component or process in the antenna or transmitter-receiver," and that its "components . . . have known and accepted parameters of performance and durability. . . . Neither the function nor the efficiency of any component is frustrated by its particular use or placement within the design of the signal processing unit." *Id.* at 50-52, 405 A.2d at 480, 481-82.

145. See note 74 *supra*.

146. *E.g.*, *People v. Donohoo*, 54 Ill. App. 3d 375, 369 N.E.2d 546 (1977). The defendant objected to the introduction of radar evidence that had been obtained by a "speed gun." A speed gun is a hand-held radar speedmeter and is no different than any other radar device except that it is portable. The defendant contended that the reliability of the speed gun should be proved by expert testimony. The court rejected this contention, stating that a speed gun operated on the Doppler principle like any other radar device, and thus, the evidence was admissible without expert testimony. Yet, the court came to this conclusion only after hearing the testimony of a non-expert witness concerning the principles and reliability of the device. *Id.* at 378, 369 N.E.2d at 548; *cf.* *State v. Boyington*, 153 N.J. Super. 252, 379 A.2d 486 (Super. Ct. App. Div. 1977) (*per curiam*) (reversing a conviction on the ground of absence of competent evidence of the scientific reliability of the speed gun). On remand, *State v. Boyington*, 159 N.J. Super. 426, 388 A.2d 276 (Monmouth County Ct. 1977), the scientific reliability was established by expert testimony. The effect of this case is to encourage judicial notice of the reliability of the speed gun in future New Jersey cases. See also *State v. Shelt*, 46 Ohio App. 2d 115, 120, 346 N.E.2d 345, 349 (1976) (Wiley, J., concurring) (After considering expert testimony regarding reliability of the MR-7 moving radar device, the concurring judge stated that "upon the publication of this

B. Accuracy

If reliability of a radar device is judicially noticed and radar evidence is admissible without expert testimony regarding its underlying operating principles, the accuracy of a particular device should be analyzed to determine the sufficiency of radar evidence to convict.

1. The prosecution should prove that the radar apparatus was tested at approximately the time of the alleged violation. The courts should not burden the prosecution, however, by requiring proof that the testing apparatus itself is accurate when the circumstances permit inferences of reliability. Thus, when dual tests, by tuning fork and speedometer calibration, for example, yield consistent results, the courts should not require that the speedometer and the tuning fork also be shown accurate. Similarly, a test by tuning fork and internal calibration¹⁴⁷ should be sufficient to show the speedometer accurate,¹⁴⁸ but a test by merely internal calibration should not be sufficient.¹⁴⁹ This latter requirement is consistent with the reasonable doubt standard in criminal proceedings.¹⁵⁰ When only one external test has been performed to check the device's accuracy, however, by use of a tuning fork, or a speedometer check, for example, the court should have discretion to determine whether the proof is sufficient to show accuracy.¹⁵¹

2. Because radar devices can be affected by external factors, and simple tests for accuracy will not reveal their presence, speed measurements from moving radar devices should be considered with greater scrutiny by the court than those obtained by stationary radar. For the evidence to be sufficient to convict, the prosecution should be required to show that the surrounding environment did not adversely affect the moving radar device. For example, moving radar should not be used along roads where billboards and other large objects such as trucks could induce a significant cosine or shadowing error,¹⁵² and thus produce incorrect speed measurements. If moving radar is, nevertheless, used under such circumstances, the prosecution should be prepared to show that the operator verified his patrol car speed as registered by the radar device with the speed shown by the patrol car speedometer.¹⁵³

3. Speed measurements from all types of radar apparatus should be

opinion, it may be judicially noticed that the MR-7 . . . using the Doppler effect, is acceptable for its proposed purpose.").

147. See notes 82, 107 *supra* and accompanying text.

148. *E.g.*, State v. McDonough, 302 Minn. 468, 225 N.W.2d 259 (1975) (per curiam) (testing by means of internal check and external tuning fork held sufficient).

149. *E.g.*, State v. Gerdes, 291 Minn. 353, 358, 191 N.W.2d 428, 431 (1971) ("To test the machine by the machine itself seems to be bootstrapping.").

150. *E.g.*, State v. Lenzen, 1 Conn. Cir. 499, 504, 24 Conn. Supp. 208, 212-13, 189 A.2d 405, 407 (Cir. Ct. 1962) ("It is elementary that the state is not required in a criminal prosecution to establish an essential element beyond a possible doubt but only beyond a reasonable doubt.").

151. *E.g.*, Commonwealth v. Whynaught, — Mass. —, —, 384 N.E.2d 1212, 1215-16 (1979)

152. See notes 30-41 *supra* and accompanying text.

153. See, *e.g.*, State v. Wojtkowiak, 170 N.J. Super. 44, 59, 405 A.2d 477, 485 (Super. Ct. Law Div. 1979); State v. Hanson, 85 Wis. 2d 233, 244, 270 N.W.2d 212, 218 (1978); Police Traffic Radar, *supra* note 4, at 19. All moving radar speed detection devices should be designed with a dual display to minimize these errors.

carefully examined by the court when there is evidence of heavy traffic.¹⁵⁴ When moving radar is used under such conditions, the speed measurement should be considered suspect, due to the possibility of error from many sources.¹⁵⁵ Indeed, it probably can be presumed that radar speedmeters should not be used under such conditions. In any event, the prosecution should be prepared to prove to the factfinder that surrounding vehicles did not result in incorrect identification of the speeding vehicle by the operator. When the mix of vehicles is diverse—large trucks and buses mixed with passenger car traffic—and a smaller vehicle is identified by the operator as the alleged speeder, the radar evidence alone should be insufficient even though other requirements are met because under these circumstances it is extremely difficult to identify the speeder conclusively by radar alone.¹⁵⁶

4. The "automatic lock" feature should not be used by radar operators, because the opportunity for incorrect identification increases.¹⁵⁷ The operator should be required to identify an alleged speeder visually before manually locking in a speed reading, so that the chance for misidentification is minimal.¹⁵⁸ This is especially true when traffic is heavy; even in light traffic, however, the opportunity for error arises due to inattentive operators, because a stray interfering signal could result in a speed reading at the time the suspect vehicle enters the zone of influence.¹⁵⁹ Admittedly, this is a more remote possibility, though not an impossible contingency.

5. The problem of electrical interference¹⁶⁰ is more difficult to deal with because proof of the absence of such interference could be virtually impossible.¹⁶¹ Consequently, requiring the prosecution to prove that no extraneous

154. See notes 52-59 *supra* and accompanying text. See also *State v. Fedje*, No. T-1979-725387MO (Dist. Ct. Hawaii Nov. 14, 1979). In *Fedje*, the court found that "if an officer attempts to ascertain the speed of a vehicle amongst a crowd of nearby vehicles . . . much depends upon the ability of the officer to make that crucial determination. . . . [T]his is a function of appropriate training, official restraint, and public, as well as judicial, scrutiny when such cases come to trial." *Id.*, slip op. at 4.

155. In addition to the cosine error, interference, and identification problems, it must be emphasized that the operator is also driving the patrol car at the time he is monitoring the radar device, and thereby introduces even more possibility for error. See pt. II *supra*.

156. See note 53 *supra*.

157. See *State v. Wojtkowiak*, 170 N.J. Super. 44, 53, 63, 405 A.2d 477, 482, 487 (Super. Ct. Law Div. 1979).

158. See note 65 *supra*.

159. *E.g.*, *State v. Wojtkowiak*, 170 N.J. Super. 44, 63, 405 A.2d 477, 487 (Super. Ct. Law Div. 1979) ("The [radar device] should not be operated in the 'automatic' position [because it may] instantaneously [capture] an interfering signal or a ghost which would not be reflected from the visible target."). See note 51 *supra*.

160. See notes 47-51 *supra* and accompanying text.

161. *E.g.*, *State v. Wojtkowiak*, 170 N.J. Super. 44, 63, 405 A.2d 477, 487 (Super. Ct. Law Div. 1979). The court suggested that the local police begin "to catalog . . . the existing sources, strength, frequency, range and direction of radiated energy which might intersect with or flow over the roads and highways," that might interfere with radar operation. *Id.* at 59, 405 A.2d at 485. Similarly, the court in *State v. Fedje*, No. T-1979-725387MO (Dist. Ct. Hawaii Nov. 14, 1979), noted that "common sense should dictate that neither the public nor the courts will tolerate the utilization of radar devices near sources of powerful radio signals, *e.g.* commercial radio and television stations among others." *Id.*, slip op. at 6.

sources interfered with the radar apparatus would be too burdensome. Because the chance of such interference is remote, to sustain a conviction the prosecution should only be required to establish that the radar device was not used near interfering sources such as high tension lines, airports, and operating radio transmitters. If police radio transmissions have affected the radar devices, violations detected when such transmissions are made should be disregarded. Similarly, heater fans should not be used while the radar device is in use, or at the least, steps should be taken to shield these items from interfering with radar operation. Even these sources of interference, however, can be identified by experienced operators,¹⁶² and thus proper training of operators is undoubtedly the best safeguard. A skilled radar operator, of unimpeached integrity, who can properly interpret radar readings and disregard those that are dubious would be the prosecution's main asset under these circumstances.

C. Operation and Operator Qualifications

The accuracy of a particular radar speedmeter cannot realistically be considered apart from the questions of proper operation and operator qualifications. It is apparent that incorrect operation of a reliable and properly functioning device will not yield accurate speed measurements. In *State v. Wojtkowiak*,¹⁶³ for example, the court emphasized that "the operational reliability of the [radar device] is largely dependent upon the training and experience of the policemen who use it."¹⁶⁴ The court also noted that operation of the moving radar device involves "a complex procedure requiring well-coordinated eye and hand movement as well as the exercise of quick judgment."¹⁶⁵ Furthermore, the operator must "also be monitoring his own [patrol car] speedometer with that of the [radar device's] readout on patrol car speed and driving his car with safety."¹⁶⁶ The court conceded that, in some situations, "such as heavy approaching traffic in multiple lanes where no one car is clearly in front, it will always be difficult if not impossible to identify a target,"¹⁶⁷ but noted that "experience [would] quickly expose such situations."¹⁶⁸ Thus, unlike the court in *State v. Aquilera*,¹⁶⁹ the court believed that experienced and well trained operators would serve as a safeguard against misuse of speed radar devices.¹⁷⁰ This view seems preferable, so long as the courts in future contested speeding prosecutions thoroughly emphasize

162. See *Field Operational Characteristics*, *supra* note 18, at 11, 14, 16.

163. 170 N.J. Super. 44, 405 A.2d 477 (Super. Ct. Law Div. 1979).

164. *Id.* at 62, 405 A.2d at 486.

165. *Id.*

166. *Id.*

167. *Id.* at 62, 405 A.2d at 486-87.

168. *Id.*, 405 A.2d at 487.

169. 48 Fla. Supp. 207 (Dade County Ct. 1979).

170. 170 N.J. Super. at 62, 405 A.2d at 487. In *Aquilera*, the state argued that adequately trained operators recognize the technical limitations of radar and would not issue summonses if there was a possibility of error. 48 Fla. Supp. at 210. The National Highway Traffic Safety Administration concluded after extensive testing of radar devices that radar is a reliable speed detection device when properly installed and operated by skilled and knowledgeable operators. The study, therefore, demonstrates the necessity for proper radar operator qualifications. Police Traffic Radar, *supra* note 4, at 4-5.

the high degree of skill and training necessary to utilize the device. Perhaps proper training should be the most important prerequisite of all the foundational elements affecting sufficiency of radar evidence. Certainly, radar operators need not be engineers; they should, however, understand not only the use of the device, but also the factors that influence radar apparatus and its technical limitations, so that speeding summonses are not issued when conditions evincing potential unreliability exist.

To this end, police officers should be required to receive some minimum degree of classroom and practical training before being certified as radar operators.¹⁷¹ The completion of such a course of training should render the radar evidence admissible, while cross examination and the satisfaction of the preceeding evidentiary safeguards concerning accuracy will aid in determining the weight of the evidence.

CONCLUSION

The conflict regarding the admissibility and sufficiency of radar evidence should be resolved. Enforcement of speed limits by the use of radar serves the laudable and necessary purposes of increasing highway safety¹⁷² and reducing consumption of dwindling energy resources.¹⁷³ The reliability errors that accompany use of radar devices may be minimized by the proposed evidentiary guidelines and the institution of improved training programs for radar operators.

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171. The lack of uniform state certification and training procedures has compelled the National Highway Traffic Safety Administration to begin to develop standards for a model radar operator training and certification program. Police Traffic Radar, *supra* note 4, at 3-4.

172. "National Safety Council studies indicate that speed and speed related violations account for over 50% of all traffic fatalities and are contributing factors in over 65% of all traffic accidents." Highway District Radar Manual, *supra* note 17, at 1. Since the introduction of an expanded program of radar speed enforcement in 1977 in New York City, there has been a noticeable decrease in the number of car accidents. N.Y. Times, Nov. 14, 1979, § B, at 2, col. 3 (16,808 accidents in 1976-77 compared to 14,710 in 1978-79).

173. "The National Highway Traffic Safety Administration believes that police traffic radar is an effective enforcement tool. The role of police traffic radar in traffic safety enforcement continues to be of critical importance, especially in view of the safety and fuel conservation benefits of the 55 mph speed limit Police traffic radar provides a means of increasing enforcement effectiveness and thus enables police administrators to better cope with the scarcity of manpower resources and rapidly increasing fuel costs." Police Traffic Radar, *supra* note 4, at 4. It is estimated that 200,000 barrels of fuel are saved each day by observance of the 55 mph national speed limit. *To Conserve Energy on the National System of Interstate and Defense Highways: Hearings on H.R. 11372 Before the Subcomm. on Energy of the House Comm. on Public Works*, 93d Cong., 1st Sess. 35 (1973) (statement of Irwin Halpern); N.Y. Times, Jan. 3, 1974, § A, at 1, col. 7; Letter from Robert A. Low, Regional Rep., U.S. Dep't of Energy, to Editor of N.Y. Times (Feb. 5, 1979), reprinted in N.Y. Times, Feb. 11, 1979, § 4, at 16, col. 4. Tests conducted by the U.S. Dep't of Transportation and the Regular Common Carrier Conference, a trucking industry organization, showed that large trucks obtain significant fuel savings by observing the 55 mph speed limit. N.Y. Times, Aug. 7, 1978, § A, at 8, col. 5; *id.*, Feb. 26, 1978, § A, at 32, col. 1.